NAVSHIPS 91824 (A)

RESTRICTED
SECURITY INFORMATION
(See Page B)

INSTRUCTION BOOK

for

TRANSDUCER SIMULATOR SM-58/UQS-T1

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

BUREAU OF SHIPS NAVY DEPARTMENT

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NAVY DEPARTMENT

Contract: NObsr-57581

Approved By BuShips: 28 May 1953

LIST OF EFFECTIVE PAGES

PAGE NUMBERS	CHANGE IN EFFECT	PAGE NUMBERS	CHANGE IN EFFECT
Title Page	Original	3-1 to 3-13	Original
A to C	Original	4-0 to 4-16	Original
i to v	Original	5-1 to 5-13	Original
1-0 to 1-6	Original	i-0 to i-3	Original
2-1 to 2-8	Original		

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
28 May 1953

From: Chief, Bureau of Ships
To: All Activities concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Transducer Simulator SM-58/UQS-T1
NAVSHIPS 91824(A)

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H. N. WALLIN
Chief of Bureau

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

TABLE OF CONTENTS

SECTION 1—GENERAL DESCRIPTION

Paragraph		*Page*
1.	Purpose	1-1
2.	Basic Principles	1-1
3.	Description	1-1
	a. Cabinet Assembly	1-1
	b. Transducer Scanner Assembly	1-2
	c. Signal and Servo Amplifier Chassis	1-4
4.	Reference Data	1-5

SECTION 2—THEORY OF OPERATION

1.	General	2-1
2.	Circuit Analysis	2-1
	a. Servo System	2-1
	b. Directional Sensitivity Circuits	2-5
	(1) Beam Pattern Formation and Rotation	2-5
	(a) Production of Acoustic Beam Pattern	2-5
	(b) The Scanner	2-6
	(c) Phasing and Shading, the Lag Line	2-7

SECTION 3—INSTALLATION

1.	Unpacking	3-1
2.	Installation	3-1
3.	Initial Tests and Adjustments	3-3
	a. Applying Equipment Power	3-3
	(1) Power on Observations	3-3
	(2) Alignment Check	3-3
4.	Conversion to Single Speed System	3-3

SECTION 4—MAINTENANCE

Paragraph		*Page*
1.	Operation	4-1
2.	Emergency Maintenance	4-1
	a. Permanently Alive Electrical Circuits	4-1
	b. Fuse Failure	4-1
3.	Performance Tests	4-1
	a. Transducer Scanner Check	4-1
4.	Corrective Maintenance	4-2
	a. Trouble Shooting	4-3
	(1) Operational Failures	4-3
	(2) Tabulation of Faults for Transducer Simulator SM-58/UQS-T1	4-3
	(3) Table of Tube Pin and Terminal Voltages and Resistances	4-4
	b. Component Replacement	4-5
	(1) Extraction of Transducer Scanner from Rack	4-5
	(2) Replacement of 36^X Synchro, B-2301	4-6
	(3) Replacement of 1^X Synchro, B-2302	4-7
	(4) Replacement of Motor Generator Unit, MG-2301	4-7
	(5) Signal and Servo Amplifier Chassis	4-8
	(6) Replacement of Transducer Scanner, Z-2301	4-8
	c. Equipment Adjustment	4-8
	(1) Synchro Zeroing	4-8
	(a) 1HCT Control Transformer, B-2302	4-8
	(b) 1HCT Control Transformer B-2301	4-8
	d. Lubrication	4-9

SECTION 5—PARTS LISTS

LIST OF ILLUSTRATIONS

SECTION 1—GENERAL DESCRIPTION

Figure	*Title*	*Page*
1-1	System Pictorial	1-0
1-2	Transducer Simulator SM-58/UQS-T1.	1-2
1-3	Transducer Simulator, Showing Interior	1-3
1-4	Transducer Simulator, Scanner Rack Withdrawn	1-4
1-5	Signal and Servo Amplifier Chassis	1-5

SECTION 2—THEORY OF OPERATION

2-1	System Block Diagram	2-2
2-2	Servo Amplifier Waveforms at 5 Degrees	2-3
2-3	Servo Amplifier Waveforms at 7.5 Degrees	2-4
2-4	Transducer Element Voltages	2-6
2-5	Lag Line	2-6
2-6	Shading Curves	2-6
2-7	Transducer Scanner Schematic Diagram	2-7

SECTION 3—INSTALLATION

Figure	*Title*	*Page*
3-1	Transducer Simulator, Showing Main Terminal Board	3-2
3-2	Transducer Scanner Rotor and Stator Alignment	3-3
3-3	System Pictorial	3-5
3-4	Mounting and Outline Dimensions	3-7
3-5	Transducer Simulator Schematic Diagram	3-9
3-6	System Interconnections Diagram	3-11

SECTION 4—MAINTENANCE

4-1	Transducer Simulator, Scanner Rack Withdrawn	4-2
4-2	Removable Components, Signal and Servo Amplifier Chassis	4-3
4-3	Transducer Scanner, Showing End Plate	4-7
4-4	Component Location, Amplifier Chassis	4-9
4-5	Transducer Simulator, Schematic Diagram	4-11
4-6	Cabinet Wiring, Transducer Simulator.	4-13
4-7	Chassis Wiring, Transducer Simulator.	4-15

LIST OF TABLES

SECTION 1—GENERAL DESCRIPTION

Table	*Title*	*Page*
1-1	Equipment Supplied	1-6
1-2	Equipment Required But Not Supplied.	1-6
1-3	Shipping Data	1-6

SECTION 4—MAINTENANCE

4-1	Table of Tube Pin and Terminal Voltages and Resistances	4-5
4-2	Coil Winding Data	4-10

SECTION 5—PARTS LISTS

Table	*Title*	*Page*
5-1	Weights and Dimensions of Spare Parts Boxes	5-2
5-2	Shipping Weights and Dimensions of Spare Parts Boxes	5-2
5-3	List of Major Units	5-2
5-4	Table of Replaceable Parts	5-3
5-5	Maintenance Parts Kit	5-10
5-6	Cross Reference Parts List	5-11
5-7	Color Codes and Miscellaneous Data	5-12
5-8	List of Manufacturers	5-13

GUARANTEE

The equipment, including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the government, without delay and at no expense to the Government, provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expecteshelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing condition, against defects in design with the understanding that if ten percent (10%) or more of any such said item, but not less than two of any such items, of the total uantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred percent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of euipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any such defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

INSTALLATION RECORD

Contract Number: NObsr-57581 Date of Contract: 25 June 1952

Serial Number of equipment.....

Date of acceptance by the Navy.....

Date of delivery to contract destination.....

Date of Completion of installation.....

Date placed in service.....

Blank spaces on this page shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date of acceptance plate located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations using form NAVSHIPS NBS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the *Bureau of Ships Manual* or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Federal stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

WARNING

Voltages over 300 volts shall be measured as follows:

1. De-energize the equipment. Ground terminals to be measured to discharge any capacitors connected to these terminals.

2. Connect meter to terminals to be measured using a range higher than the expected voltage.

3. WITHOUT TOUCHING METER OR TEST LEADS, energize the equipment and read the meter.

4. De-energize the equipment. Ground the terminals connected to the meter before disconnecting meter.

Note

a. MAKE SURE you are NOT GROUNDED whenever you are adjusting equipment or using measuring equipment.

b. In general, USE ONE HAND only when servicing live equipment.

c. If test meter must be held or adjusted while voltage is applied GROUND the case of the meter before starting measurement and DO NOT touch the live equipment or personnel working on live equipment while you are holding the meter. Some moving vane type meters should not be grounded. These should not be held during measurements.

d. DO NOT FORGET that high voltages MAY BE PRESENT across terminals that are normally low voltage, due to equipment breakdown. Be careful even when measuring low voltages.

e. DO NOT use test equipment known to be in poor condition.

f. High voltage high capacity capacitors should be discharged with a grounding stick with approximately 10 ohms in series with the ground line. Where neither terminal of a capacitor is grounded, short capacitor terminals to each other.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of the *Bureau of Ships Manual* or superseding instructions on the subject of radio-safety precautions to be observed.

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS:

Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

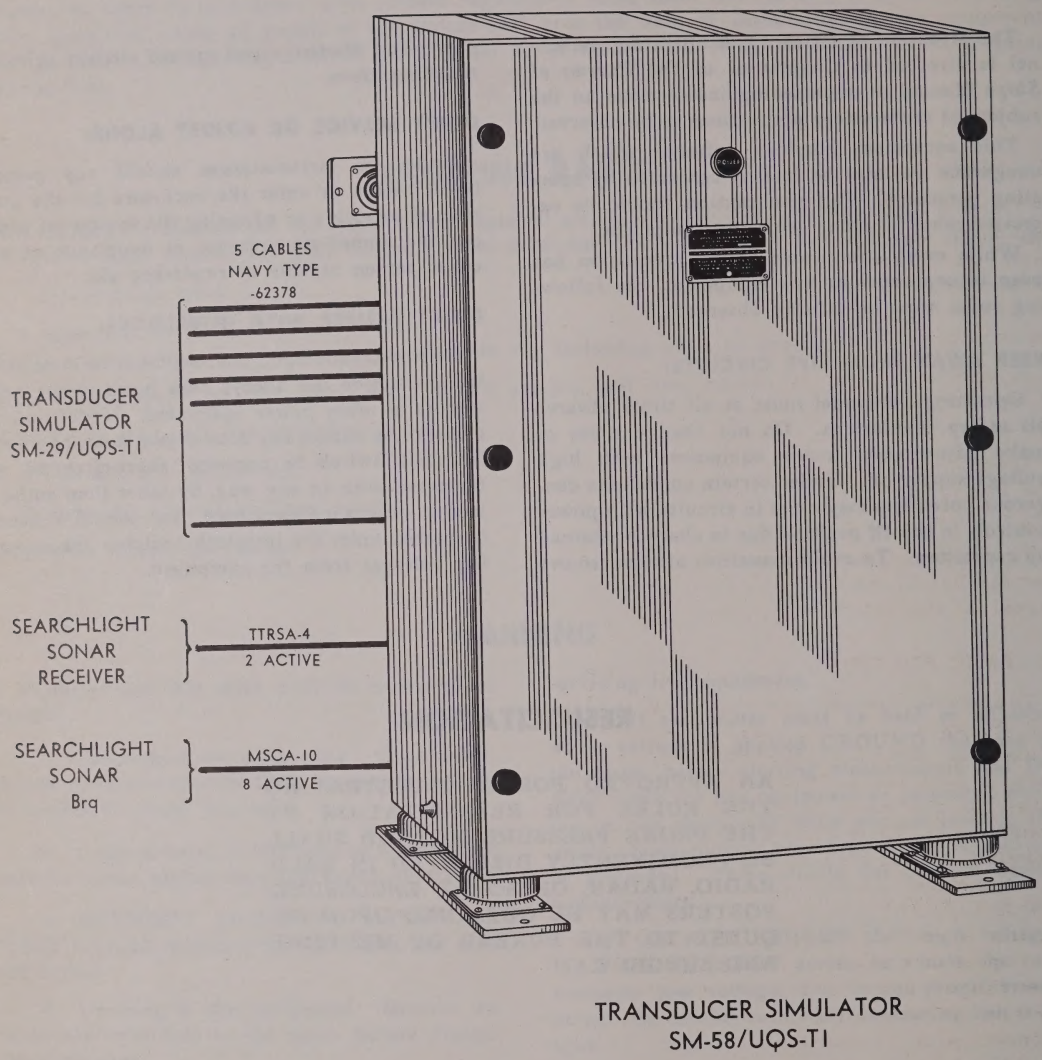


Figure 1-1. System Pictorial

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE.

Transducer Simulator SM-58/UQS-T1 is an equipment designed to adapt Sonar Training Set AN/UQS-T1 for use with "searchlight" types of azimuth sonar sets. It performs the following functions for, and in conjunction with, these equipments:

It accepts a simulated target bearing from Sonar Target Simulator SM-28/UQS-T1 of the Sonar Training Set.

It accepts a relative bearing synchro order from the associated "searchlight" equipment for training its transducer scanner.

It provides an output from the transducer scanner lag line in the form of a "left" and "right" signal for the "searchlight" equipment receiver.

2. BASIC PRINCIPLES.

In operation Transducer Simulator SM-58/UQS-T1 accepts a simulated transducer signal from Transducer Simulator SM-29/UQS-T1, which, in turn, obtains the simulated target signal from either of two Sonar Target Simulators of the training set. These signals arrive as directional noise signals and are connected to the stators of the transducer scanner in Transducer Simulator SM-58/UQS-T1. The transducer scanner servo system accepts a relative bearing synchro order at 1 speed or 1 and 36 speed from the associated "searchlight" sonar set and utilizes these orders to train the rotor of the transducer scanner. The scanner, with its sharp beam pattern, delivers "left" and "right" voltages for all echo or noise signals along that bearing. These "left" and "right" signals are each connected to the input of a single stage cathode follower, which in turn provides a "left" and "right" channel signal at an impedance level of approximately 100 ohms for transmission to the receiver input of the associated "searchlight" equipment.

3. DESCRIPTION.

Transducer Simulator SM-58/UQS-T1 consists of a steel cabinet approximately 32-5/8 inches high by 24-1/2 inches wide and 17-5/16 inches deep overall. Mounting facilities are provided at the bottom and rear of the cabinet by a shock mount and pad arrangement suitable for bolting or welding to the deck. All of the necessary components are completely enclosed within the cabinet and there are no external controls. The unit consists of the following assemblies:

Cabinet Assembly
Transducer Scanner Assembly
Signal and Servo Amplifier

a. CABINET ASSEMBLY.

The cabinet is a welded steel structure with top, bottom, back and both sides welded to the framework. Access to the interior is by means of a removable door fastened by six captive screws along the front sides of the cabinet.

With the door removed all assemblies within the cabinet are accessible. Mounted in the upper half of the cabinet is the signal and servo amplifier chassis, hinged vertically at the left side of the cabinet. When the chassis is swung outward access is provided to the terminal boards mounted along the left and rear wall of the cabinet. Also mounted on the left rear of the cabinet is a terminal tube plate which provides entry to or from the transducer simulator to other units of the sonar system. Mounted along the right wall of the cabinet are various items including spare fuses, an Allen wrench, two support rods and two convenience outlets, as shown in figure 1-3.

The lower half of the cabinet contains the transducer scanner assembly, mounted on suitable shock mounts in a sliding rack device which permits partial withdrawal of the complete scanner assembly for maintenance purposes.

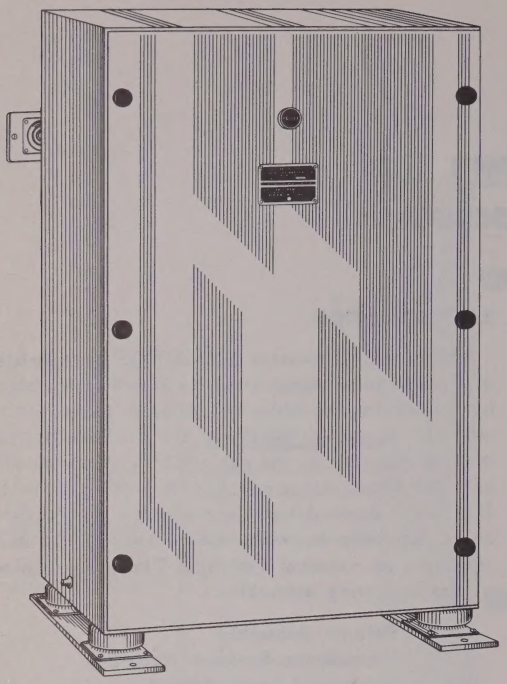


Figure 1-2. Transducer Simulator SM-58/UQS-T1

The electrical wiring of the cabinet assembly is relatively simple. The 23B terminal board on the upper rear wall of the cabinet is connected by a cabled lead set to the 48 terminals on the transducer scanner. The cabinet wiring from the signal and servo amplifier chassis is terminated at the 23C terminal board. Connections from the transducer scanner synchro system is made to the 23D terminal board, mounted on the scanner rack assembly.

b. TRANSDUCER SCANNER ASSEMBLY.

The transducer scanner is an extensive mechanical structure located within the scanner rack. The unit is approximately 15 inches long and 13-1/2 inches square. Structurally it consists of two large cast iron cups accurately machined and doweled and bolted together at their open ends. At the left end of the assembly is a circular terminal board which provides connections to the 48 leads from the 23B terminal board. The terminals on this circular board are directly connected by short conducting loops to pins which protrude through the left hand surface of the scanner proper, the pins being insulated by rubber grommets. A mica and glass composition (Mykroy) disk 11 inches in diameter and 3/16 of an inch thick is secured to a cast-iron backing plate which is bolted to the machined inner surface of this left hand end bell. The outer plane surface of this disk is coated with aluminum and scribed with 48 radial divisions, forming 48 separate conducting segments. Each segment has a metallized recess which holds the head of a connection pin which passes through the Mykroy plate and metal backing plate, emerging as a solder type terminal. This provides a complete circuit from any specific outer terminal to a corresponding segment on the Mykroy plate.

The rotor of the scanner is secured by two preloaded ball bearings located in the left hand end bell and a roller bearing in the right hand end bell. A Mykroy plate and metal backing plate assembly, identical to the stator plate assembly, is bolted to a large steel hub shrunk on the rotor shaft. With the shaft secured in the pre-loaded bearings, and the latter located in the left hand end bell, an air gap of from .0035 to .0040 of an inch is obtained between the rotor and stator plates. With the segments of both plates lined up, 48 equal capacitors of 80 to 100 mmf capacity are thus formed; these constitute the means for connection from the outer circular terminal board to the electrical network carried on the rotor assembly. This network is in effect two lag lines, each connected to eight consecutive rotor segments. The result is a split receiving beam, providing for separate signals from the "right" and "left" halves of the beam. This network is mounted in a cast aluminum housing and the output connections are carried to suitable slip rings mounted on the rotor shaft. Carbon silver brush members inserted through the rear wall of the right hand end bell engage these slip rings, thus making accessible the electrical signal equivalent to the acoustic beam obtaining at any instant. A shielded cable connects to the brush mounts and is brought out through the side wall of the scanner for ultimate connection to the "searchlight" sonar equipment through a suitable amplifier within the equipment.

The scanner shaft is gear driven by a servo system mounted in a cast plate secured to the right hand end bell. The servo motor is of the induction type and is capable of driving the scanner rotor at a speed of eight rpm. Response of the servo system is subject to the positioning of two 1HCT control transformers in the gear

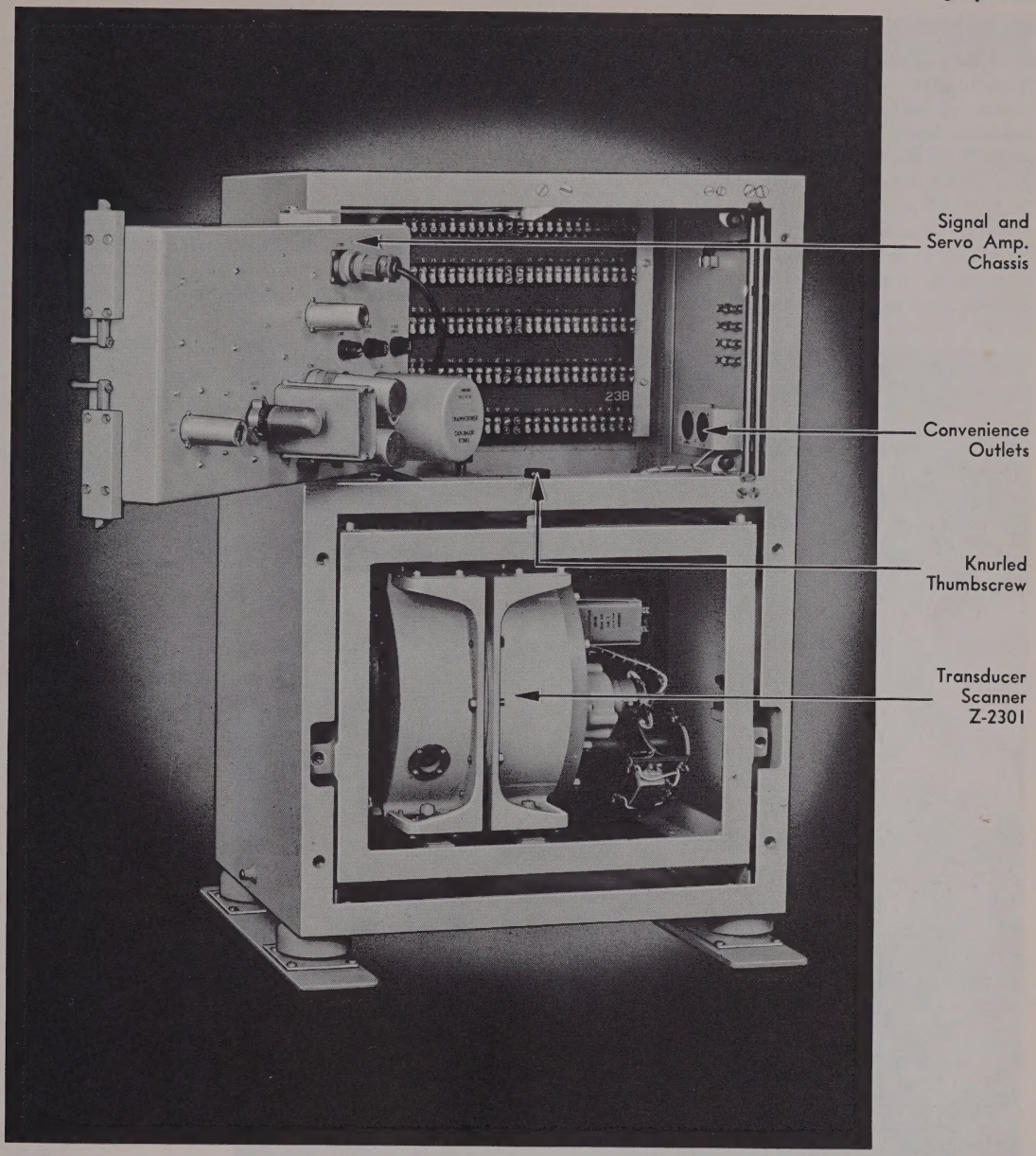


Figure 1-3. Transducer Simulator, Showing Interior

train. These are connected to the 1 and 36 speed Brq (relative bearing) synchro orders from the related equipment. The servo motor is of some particular interest since it includes an auxiliary unit, an induction generator which provides braking feedback to the servo amplifier, to prevent hunting at the balance point.

The practical accomplishment of the arrangement of mechanical and electrical elements which go to make up the scanner can now be stated.

The rotor may be turned to any desired angle by means of a synchro training order from the "searchlight" sonar equipment. The rotor, furthermore, performs the task of forming a split acoustic beam from any 16 consecutive stator segments. Since the stator segments are permanently connected to specific simulated transducer staves, the rotor performs the ultimate task of forming an acoustic beam from the output of any 16 consecutive simulated transducer staves. Since a scanning transducer would normally be fixed permanently to the ship and not rotated, its orientation would have a fixed relative bearing. Rotation of the scanner rotor, therefore, turns the acoustic beam to a known direction with respect to the ship and the angular position of the rotor is, therefore, the equivalent of the relative bearing.

c. SIGNAL AND SERVO AMPLIFIER.

The chassis located in the upper portion of the cabinet contains both the signal and servo amplifiers along with the anode and heater power required for their operation.

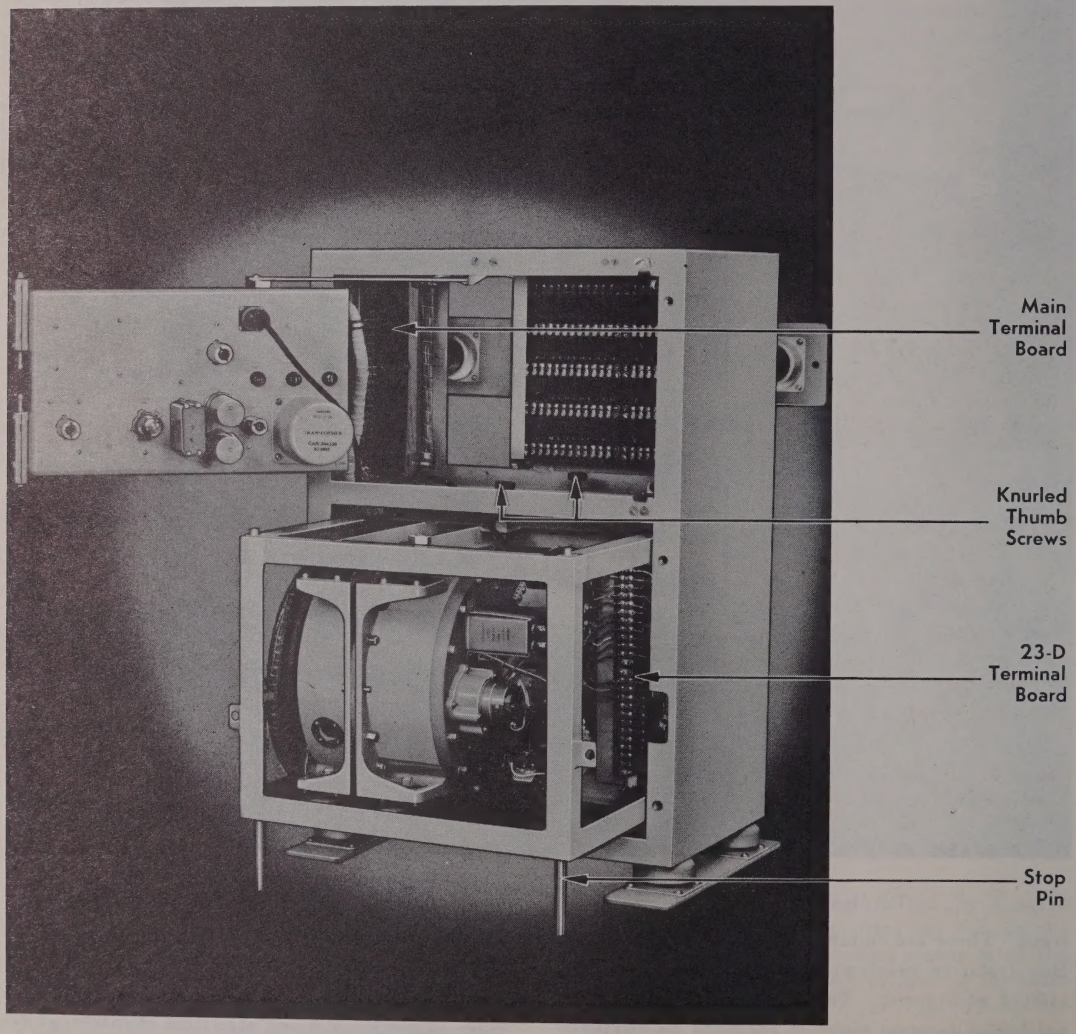


Figure 1-4. Transducer Simulator, Scanner Rack Withdrawn

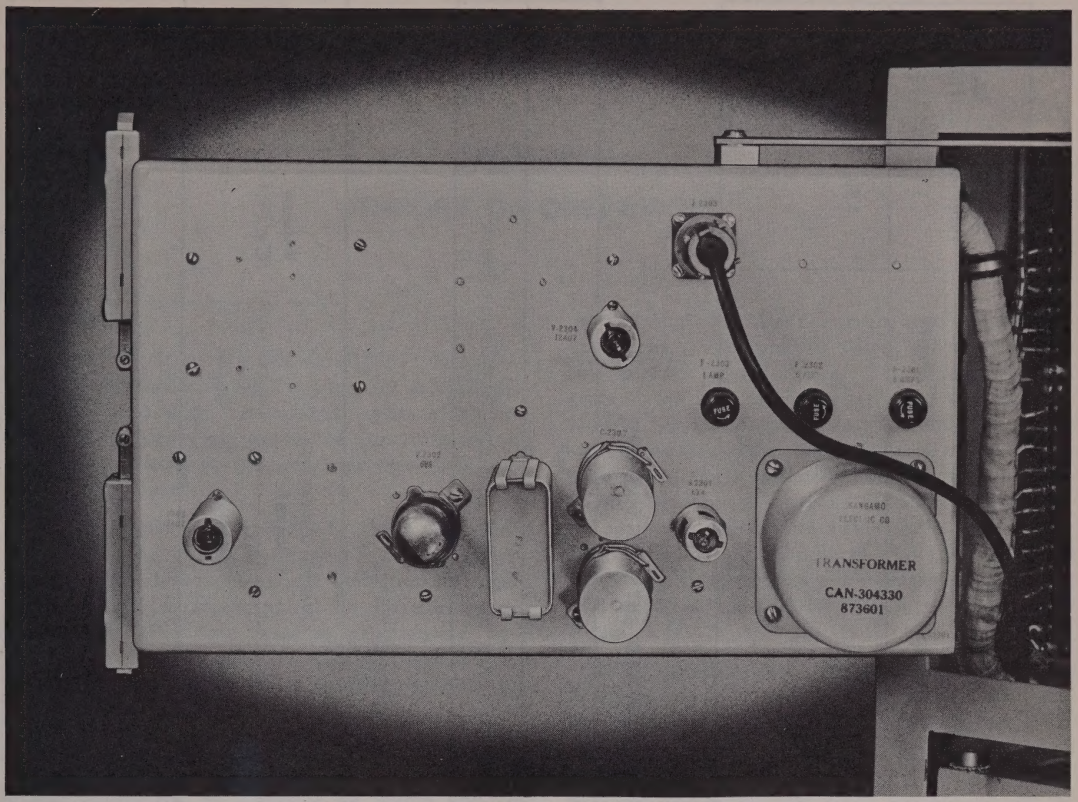


Figure 1-5. Signal and Servo Amplifier Chassis

The signal amplifier consists of a dual triode used as a cathode follower in order to provide a low impedance output for transmission of the acoustic beam signals to the audio channels of the "searchlight" equipment. The servo amplifier uses a dual triode in the input and a triode-connected tetrode used as a cathode follower for the output stage.

The power supply is of conventional design using a full-wave high vacuum rectifier and a resistance-capacitance filter.

4. REFERENCE DATA.

a. Nomenclature: Transducer Simulator SM-58/UQS-T1.

b. Contract: NObsr-57581, dated 25 June, 1952.

c. Contractor: Sangamo Electric Company, Springfield, Illinois.

d. Cognizant Naval Inspector: Resident Inspector of Naval Material, St. Louis, Missouri.

e. Number of Packages Involved in Complete Shipment of Equipment..... 1

f. Total Cubic Contacts (including spares):
Crated ..... 24 cu. ft.
Uncrated ..... 6.9 cu. ft.

g. Total Weight (including spares):
Crated ..... 437 lbs.
Uncrated ..... 371 lbs.

h. Audio Output Impedance.....100 ohms

i. Power Supply: 117 volts, 60 cycle, single-phase. Allowable voltage variation 10%, allowable frequency variation, 2 cycles.

j. Power Requirements:

Normal Operation.....54 watts at 117 v, 60 cyc, 0.94 P.F.

k. Heat Dissipation .....54 watts

TABLE 1-1. EQUIPMENT SUPPLIED

Quantity Per Equipment	Name of Unit	Navy Designation	Overall Dimensions (Inches)			Volume (Cu. Ft.)	Weight (Lbs.)
			Height	Width	Depth		
1	Transducer Simulator	SM-58/UQS-T1	32-5/8	21-1/2	17	6.90	371
1	Maintenance Parts Kit						
2	Instruction Book	NAVSHIPS 91824(A)					

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

Quantity Per Equipment	Name of Unit
	Cable Specified by Bureau of Ships Installation Plans

TABLE 1-3. SHIPPING DATA

Shipping Box Number	Contents		Overall Dimensions (Inches)			Volume (Cu. Ft.)	Weight (Lbs.)
	Name	Navy Designation	Height	Width	Depth		
1	Transducer Simulator	SM-58/UQS-T1	48	27	32	24	437
	Maintenance Parts Kit						
	Instruction Book (2)	NAVSHIPS 91824(A)					

SECTION 2

THEORY OF OPERATION

1. GENERAL.

Transducer Simulator SM-58/UQS-T1 is a device which enables Sonar Training Set AN/UQS-T1 to be used with "searchlight" types of sonar sets. It performs the necessary functions automatically as long as the auxiliary equipment is operating properly.

A block diagram, figure 2-1, shows the overall functioning of the equipment. During operation, 48 simulated transducer elements are connected to the 48 stator plates of the transducer scanner, Z-2301. Any noise or echo signals appearing at the simulated transducer elements are, therefore, delivered to the transducer scanner in the equipment.

Transducer scanner Z-2301, whose rotor can be positioned by a synchro order from the associated equipment, is a device by which any 16 consecutive simulated transducer signals may be selected and combined to form a dual channel ("left" and "right") acoustic beam for eventual use in the receiver circuits of the "searchlight" equipment. The "left" and "right" channel signals are connected to the "searchlight" receiver by means of a cathode follower stage for each signal, the cathode follower providing a low impedance source to match the input impedance of the receiver. Operation of the training control on the auxiliary equipment automatically "trains" the equipment transducer scanner to the desired bearing.

A suitable power supply is included in the equipment to satisfy the heater and anode requirements for the servo amplifier and cathode follower stages.

2. CIRCUIT ANALYSIS

a. SERVO SYSTEM.

Transducer scanner, Z-2301, is positioned by a servo motor-generator, MG-2301, in response to the training control orders from the "searchlight" equipment. The synchro orders are accepted by two control transformers, B-2301 and B-2302, geared 36:1 and 1:1 respectively to the rotor of Z-2301. When connected into a standard synchro system the maximum rotor voltage of these 1HCTs is 55 volts. It is assumed that the control transformers are correctly zeroed and that the mechanical system is in error with respect to the training control order by an angle Θ. In this event the rms rotor voltage of the 1^X control transformer will be 55 sin Θ and of the 36^X control transformer 55 sin 36 Θ.

As Θ increases from zero it is evident that the first maximum from the 36^X control transformer will be reached at $\Theta = 2.5$ degrees. When Θ becomes 7.5 degrees the polarity of the 36^X control transformer will be reversed and the signal will again be at a maximum. (The purpose of the 36^X order is to insure the utmost precision in reducing Θ to zero. If only 1^X units were employed, it is evident that the probably inaccuracy would be the sum of the inaccuracies of the transmitter and the control transformer, approximately one degree.) It is a requirement of the circuit, therefore, that the 36^X system control the positioning of the servo mechanism as Θ approaches zero. Until Θ becomes greater than five degrees, the polarity of the connections to the servo motor is such that amplification of the 36^X signal results in driving Θ to zero. If, however, Θ be greater than five degrees, the polarity of an amplified signal from the 36^X control transformer must drive the system to increase Θ until the 36^X signal is again zero, which would occur at $\Theta = 10$ degrees. The servo system would then be, and remain, ten degrees out of step.

The polarity of the signal from the 1^X control transformer will not reverse, however, until Θ exceeds 180 degrees, thus it is evident that control by the 1^X order cannot result in a spurious position of the servo system.

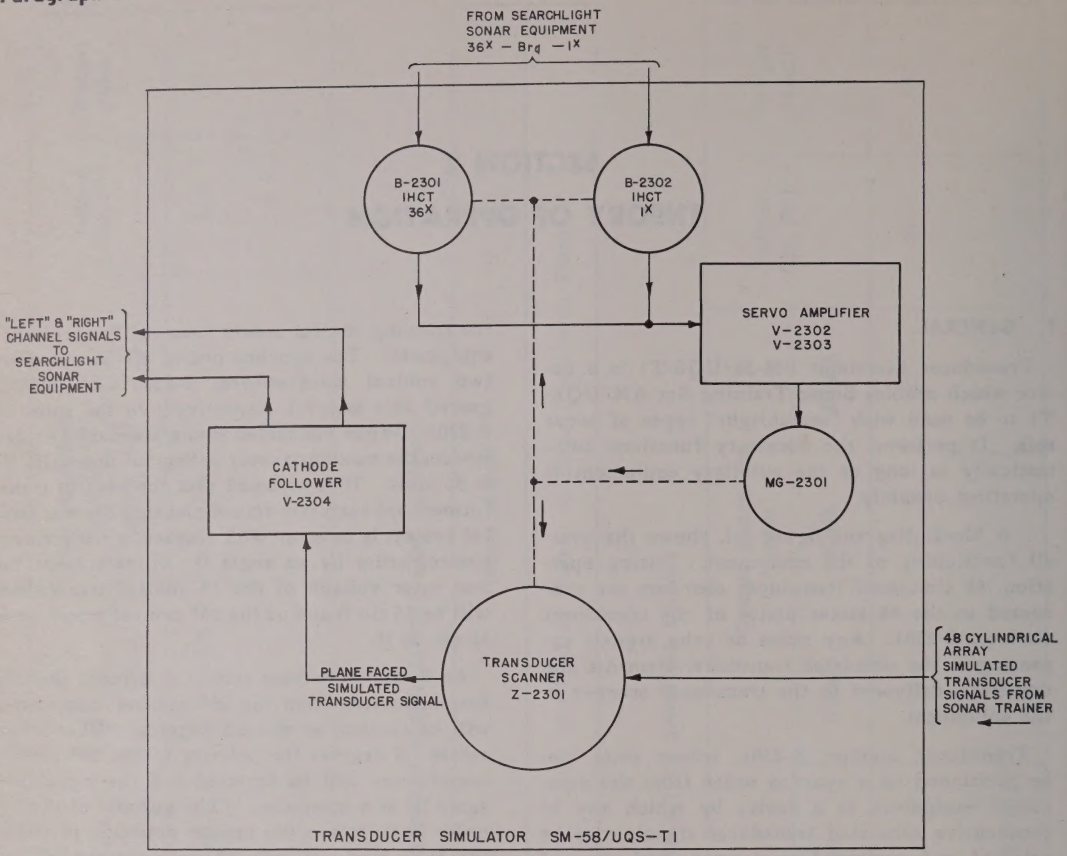

FROM SEARCHLIGHT SONAR EQUIPMENT
36X – Brg – 1X
B-2301 IHCT 36X
B-2302 IHCT 1X
SERVO AMPLIFIER V-2302 V-2303
"LEFT" & "RIGHT" CHANNEL SIGNALS TO SEARCHLIGHT SONAR EQUIPMENT
CATHODE FOLLOWER V-2304
MG-2301
TRANSDUCER SCANNER Z-2301
PLANE FACED SIMULATED TRANSDUCER SIGNAL
48 CYLINDRICAL ARRAY SIMULATED TRANSDUCER SIGNALS FROM SONAR TRAINER
TRANSDUCER SIMULATOR SM-58/UQS-T1

Figure 2-1. System Block Diagram

In summation, it can be stated that the circuit requirement is that the 36^X order must control the servo mechanism for small values of Θ and that for values in excess of plus or minus five degrees, the 1^X system must control. The method of accomplishment is described below.

The 1^X signal is injected into the cathode circuit of one section of twin triode V-2303, self-biased by resistor R-2311, the triode current passing through the winding of the control transformer. The triode current and winding resistance are such that a positive bias of 3.4 volts appears at the junction of resistors R-2311, R-2314 and R-2315. The instantaneous voltage at this point is therefore

$$3.4 + (\sqrt{2})\ (55)\ (\sin \Theta)\ (\sin wt) \qquad (1)$$

The grid of the triode is connected through R-2310 to crystal diodes CR-2301 and CR-2302, which limit the signals to the grid between the values of plus 6.8 volts and zero volts. The signal to the two diodes is from the rotor terminal of the control transformer through resistors R-2312, R-2314 and R-2315. Neglecting the voltage introduced across R-2313 and R-2315 by the induction generator, the limiting voltage for the positive half of the A.C. wave is +6.8 volts and during the negative portion of the wave the limiting voltage is zero volts. The 3.4 volt bias of R-2314 and the signal source therefore means that limiting will occur if the amplitude of the A.C. signal is equal to or greater than 3.4 volts. The signal amplitude reaches this value when

$$(\sqrt{2})\ (55)\ (\sin \Theta) = 3.4 \qquad (2)$$

and therefore limiting does not occur for values of Θ from zero to 2.5 degrees. For values of Θ less than 2.5 degrees, the signal injected into the cathode and the grid are identical and there will

be no output at the anode of the triode except for a very small component which is the equivalent of the effect caused by a power supply ripple equal to the injected cathode signal. The pin 1 anode is capacitively coupled to the pin 7 grid. One fourth of the 36^X signal is injected into the pin 8 cathode circuit by means of resistors R-2305 and R-2306 and their values serve to degenerate the amplification to a value of six. Therefore there appears at the pin 6 anode of V-2303 a voltage one and one-half times the 36^X signal and this voltage is coupled to the grid of the triode-connected amplifier, V-2302, by capacitor C-2304. This servo amplifier output stage is connected as a cathode follower to operate the variable phase servo motor, MG-2301, thus eliminating a transformer and providing some additional damping. The cathode of V-2302 supplies the variable phase of the motor as a circuit parallel tuned by capacitor C-2303. The fixed phase of the motor is energized from the same line as the synchro transmitters through capacitor C-2302 to provide correct phase relationship and to limit the loss to a suitable level.

When Θ exceeds 2.5 degrees the signal amplitude at the pin 3 cathode of the 1^X amplifier, V-2303, can increase to the maximum of 55 volts. The pin 2 grid, however, is constrained to positive swings of 6.8 volts and negative swings of zero volts. There is consequently established a voltage difference between grid and cathode during those portions of the wave when the A.C. signal amplitude exceeds plus or minus 3.4 volts. During this part of the wave that portion of the A.C. signal in excess of 3.4 volts is amplified at the full gain of the triode and appears at the pin 7 grid of V-2303 with a gain of ten. When $\Theta = 5$ degrees, the 36^X signal becomes zero and the only signal at the pin 7 grid is that produced by the pin 1 anode, which is the amplified 1^X order. The negative polarity of the control transformers must be such that this amplifier delivers a signal to the grid of V-2302 which has the same polarity as a signal obtained from the 36^X control transformer for values of Θ between zero and five degrees. This must be so if the 1^X signal is to drive the motor in a direction to reduce Θ to zero. The waveform of the signal at the pin 7 grid of V-2303 when $\Theta = 5$ degrees is indicated in figure 2-2*(a)*

The amplitude is approximately 35 volts but the signal is zero for very definite portions of the wave which represents the portion during which the 1^X signal is less than plus or minus 3.4 volts. This signal level as delivered to the pin 7

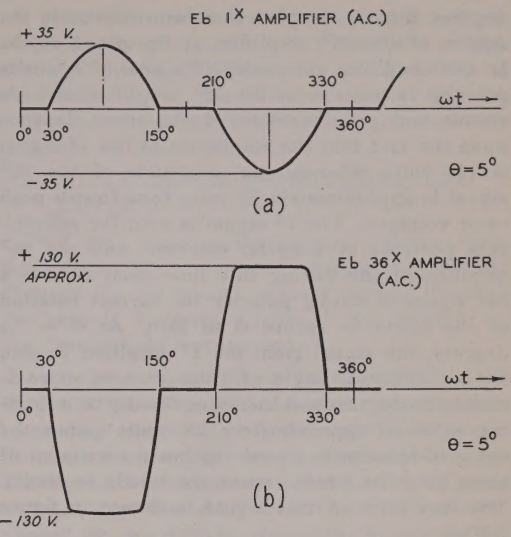


Figure 2-2. Servo Amplifier Waveforms at 5 Degrees

grid of the 36^X amplifier is obviously excessive and the amplifier limits, delivering to the grid of V-2302 a waveform as shown in figure 2-2*(b)*. The load in the cathode of the servo output tube, V-2302, is a parallel tuned circuit and the waveform of the grid signal produces an entirely satisfactory voltage across the servo motor, the harmonic content of the grid signal having negligible effect on the motor performance.

The power output tube, V-2302, is triode connected, as previously mentioned, with the tuned motor winding in the cathode circuit. The anode receives raw rectified 120 cycle pulses from the power supply rectifier, V-2301, by nature of the connection to the cathode of the rectifier tube. The phase and amplitude of the voltage applied to the grid of V-2302 determines the size of the 60 cycle component existing across the motor coil of the servo motor. While the 120 cycle component across the motor winding produces only damping effects the 60 cycle component produces a servo restoring torque.

It should be clear that for values of Θ between 2.5 degrees and five degrees, when the 1^X signal is beginning to appear at the 36^X amplifier grid, this signal will merely aid whatever 36^X signal is present in the cathode, since both signals must tend to drive the motor in the same direction for values of Θ between zero and five degrees, as previously explained. When Θ increases to 7.5

degrees, a more complex waveform results in the output of the 36^X amplifier, at the pin 6 anode. In this condition maximum 36^X signal of opposite polarity is present in the 36^X amplifier cathode circuit and proper action of the servo depends upon the fact that the amplitude of the 1^X signal is 130 volts, whereas the amplitude of the 36^X signal is approximately 20 volts (one-fourth peak rotor voltage). The 1^X signal is zero for appreciable portions of a cycle, however, and the 36^X amplifier triode during this time must receive a net signal of wrong polarity for correct rotation of the motor to reduce Θ to zero. At $\Theta = 7.5$ degrees, the signal from the 1^X amplifier is zero for an electrical angle of from zero to approximately 20 degrees and increases rapidly to a limiting value of approximately 130 volts (since the net grid-to-cathode signal reaches a maximum of about 15 volts which causes the triode to limit). The waveform of this signal is shown in figure 2-3*(a)*.

For the first 20 degrees of a cycle, the pin 8 cathode of V-2303 goes positive and since the grid signal is zero, the anode, pin 6, potential increases. At 20 degrees the grid commences to go positive as the 1^X signal becomes amplified and the A.C. potential of the pin 6 anode rapidly reduces to zero, goes negative and limits. Toward the end of the half cycle as the 1^X signal diminishes the anode again goes positive reaching a maximum at an electrical angle of 160 degrees and the process inverted repeats in the next half cycle. The waveform of the pin 6 anode of the 36^X amplifier is shown in figure 2-3*(b)*. So far as the motor is concerned, this peculiar waveform is of no consequence because of the tuned circuit and the filtering action of the motor itself. It is only necessary that the integration of the area of the voltage wave for a half cycle have correct polarity for the desired direction of motor rotation. For most suitable action of the servo system, however, it is desirable that the voltage at the motor does not dip too low when going through the 7.5 degree position of Θ. For this reason, a definite relationship of the amplification of the 1^X signal and the proportion of the 36^X signal employed must be maintained. The minimum requirement is that the percentage of the 36^X signal employed, divided by the gain of the 1^X amplifier is equal to, or less than, 1/36. As Θ continues to increase, the "notch" in the signal to the grid of V-2302 diminishes and vanishes between the limits of Θ = ten degrees to 15 degrees, since in this interval the results of the

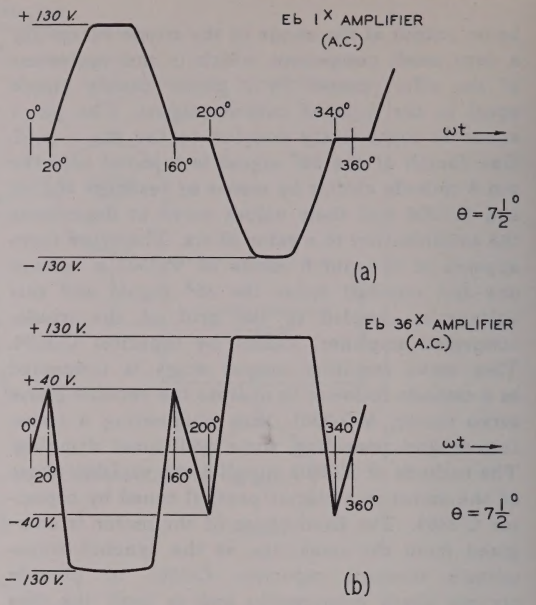


Figure 2-3. Servo Amplifier Waveforms at 7.5 Degrees

two control transformer signals have the same polarity. At 17.5 degrees the "notch" is again at maximum but the magnitude is reduced as compared with that obtaining at $\Theta = 7.5$ degrees because the magnitude of the 1^X signal has more than doubled and the electrical angle, during which the 1^X signal at the pin 7 grid of V-2303 is zero, has diminished. As Θ is further increased the "notch" finally becomes nearly imperceptible.

For small values of Θ, less than 2.5 degrees, one factor which controls the accuracy of the positioning, as well as the rapidity with which the servo motor restores the system to balance, is called the "stiffness" of the system. It consists essentially of the gain from the 36^X order to the variable phase of the servo motor. Greater "stiffness" results in more sensitive and more rapid positioning for small values of Θ but also increases the tendency of the system to oscillate if the damping factor is not adequate for a given system "stiffness" and moment of inertia. A serious disadvantage to a large damping factor is that the top running speed is proportionately reduced, hence a discontinuous form of damping is employed in this servo system. This damping factor, produced electrically by the induction generator of MG-2301, is effective when the displacement Θ is less than 2.5 degrees and the motor is essentially controlled by the 36^X order, but is minimized when Θ

is greater than 2.5 degrees, so that the motor may operate at top speed when driven by the 1^X order.

This is accomplished by introducing the induction generator voltage into the limiting circuit of CR-2301, CR-2303 and V-2303, used with the 1^X signal. This voltage, which is proportional to the speed of the servo motor, appears across resistor R-2315 and its electrical phase is made to agree with 1^X order from B-2302, by means of R-2301, R-2302 and C-2301 in the fixed phase excitation for the induction generator.

Referring again to the limiting used in the grid circuit of V-2303, it will be seen that the voltage injected into the cathode circuit is only the 1^X order, while the voltage to the pin 2 grid of V-2303 is the sum of the 1^X order and the induction generator signal, limited at plus or minus 3.4 volts with respect to the 1^X signal entry point from the rotor of B-2302. The action of this damping voltage can be explained by a consideration of the voltages resulting for values of Θ greater than 2.5 degrees and less than 2.5 degrees.

When Θ is greater than 2.5 degrees, the 1^X order is greater than 3.4 volts and the grid signal is limited to that value, hence the output at the pin 1 anode of V-2303 is essentially the amplified 1^X order injected into the cathode circuit. As explained above, this amplified 1^X order overrides the 36^X order in the second section of V-2303, thus delivering to the servo motor a voltage essentially that of the amplified 1^X order. Since both the damping voltage and the 36^X order represent such a small part of this signal, the servo motor can operate at top speed in restoring the system to zero. When the displacement, Θ of the system, has been reduced to a value less than 2.5 degrees, but the sum of the 1^X order and the damping voltage has an amplitude greater than 3.4 volts, the pin 2 grid signal to V-2303 will consist of both components whenever the instantaneous value of the sum is less than 3.4 volts. At those instants, the amount of the 1^X order in the grid circuit will be cancelled by the 1^X order in the cathode circuit, leaving only the damping voltage to be amplified. Thus each electrical cycle will consist of the amplfiied 1^X order alone while the grid circuit is limiting and of the amplified damping voltage alone for the part of the cycle when the grid signal is not limiting.

For still smaller values of Θ, where the sum of 1^X order and the voltage from the induction generator is less than 3.4 volts, the entire 1^X order in the grid circuit of V-2303 will be cancelled by the same 1^X order in the cathode circuit and the output at the pin 1 anode of V-2303 will consist solely of the amplified damping voltage. This, in combination with the 36^X order, provides the necessary damping factor as the system approaches its final position.

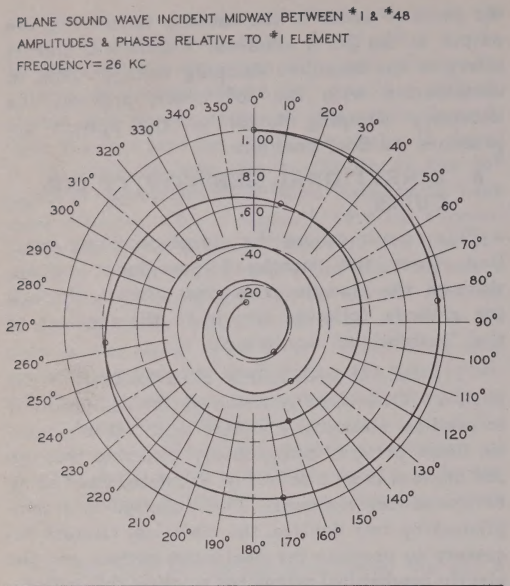
b. DIRECTIONAL SENSITIVITY CIRCUITS.

This circuit covers the signal receiving function from the simulated transducer circuit, through the transducer scanner circuit, through the cathode follower circuit to the receiver of the "searchlight" equipment.

(1) BEAM PATTERN FORMATION AND ROTATION.—One function of the equipment is to produce electrically a "left" and "right" acoustic beam pattern, continuously rotatable through 360 degrees from a source of simulated fixed array of transducer elements. This function is accomplished by two devices, the electrical circuits necessary to produce the dual beam pattern and the electro-mechanical means for rotating this pattern.

(a) PRODUCTION OF ACOUSTIC BEAM PATTERN.—The production of an optimum beam pattern from a fixed array of receptors is a fairly well known art and consists of modification of the voltages from the individual receptors, dependent upon the geometry of the array. The phasing requirements are imposed by the fact that this array of transducer elements is cylindrical and therefore the voltages induced in these elements by a plane sound wave will differ in electrical phase, unlike those which would exist in a plane faced transducer. The total voltage from a group of elements facing the sound source will be maximum when all the signals have been shifted to be in phase with each other and the resulting beam pattern will be similar to that of a plane faced transducer of approximately equal dimensions but without "shading" to reduce the side lobe level. This phasing requirement is accomplished by the use of a linear phase shift "lag line" in order that the phasing will remain correct as the frequency is changed.

The usual beam pattern for an unshaded transducer consists of a major lobe accompanied by minor lobes on each side which decrease in sensitivity as the angle from the main lobe increases. Altering the relative amplitude of these signals can result in a reduction of the level of the more adjacent minor lobes at the expense of increasing the very small lobes which are at a large angle from the main beam. The optimum signal-to-noise



ELEMENT	1	2	3	4	5	6	7	8	9	10	11	12
AMPLITUDE	1.00	0.99	0.97	0.92	0.79	0.62	0.54	0.45	0.36	0.25	0.18	0.12
PHASE	0°	31°	84°	170°	264°	373°	520°	680°	867°	1031°	1224°	1422°

Figure 2-4. Transducer Element Voltages

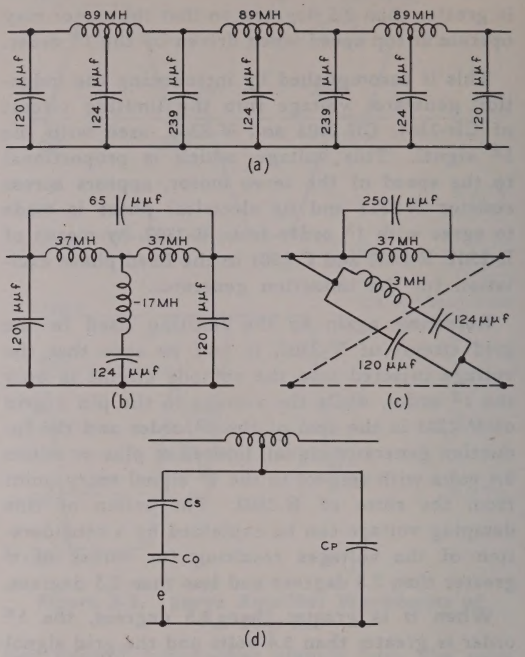


Figure 2-5. Lag Line

ratio occurs for such a shading that the minor lobes have all been brought to the same level and the consequent widening of the main beam is very slight. This shading is accomplished by selecting the proper fraction of each of the signals which are to be phased or added.

(b) THE SCANNER.—The necessity for electrically rotating the beam pattern naturally imposes cylindrical symmetry upon the fixed array of transducer elements. The use of the lag line and shading then results in a beam pattern which could only be "switched" by discrete jumps, corresponding to one element of the array, to 48 positions in azimuth, or 7-1/2 degree steps. Since smooth rotation of the beam is desired, some form of interpolation is necessary and this is provided by the capacitive device commonly called a scanning switch or transducer scanner. In this device, the signals from the 48 simulated transducer elements are connected to 48 capacitor segments on a stationary plate. The beam forming circuit is connected to an appropriate number of similar segments on a second plate, the rotation of which will shift the capacitive coupling of the beam forming network smoothly to successive groups of transducer elements. In this equipment the rotor of the scanner is positioned by synchro orders from the associated "searchlight" system.

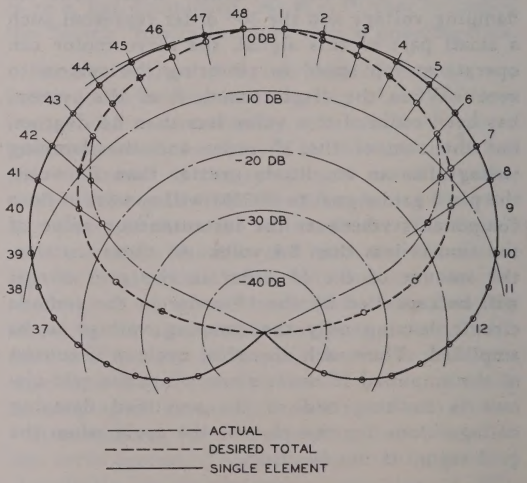


Figure 2-6. Shading Curves

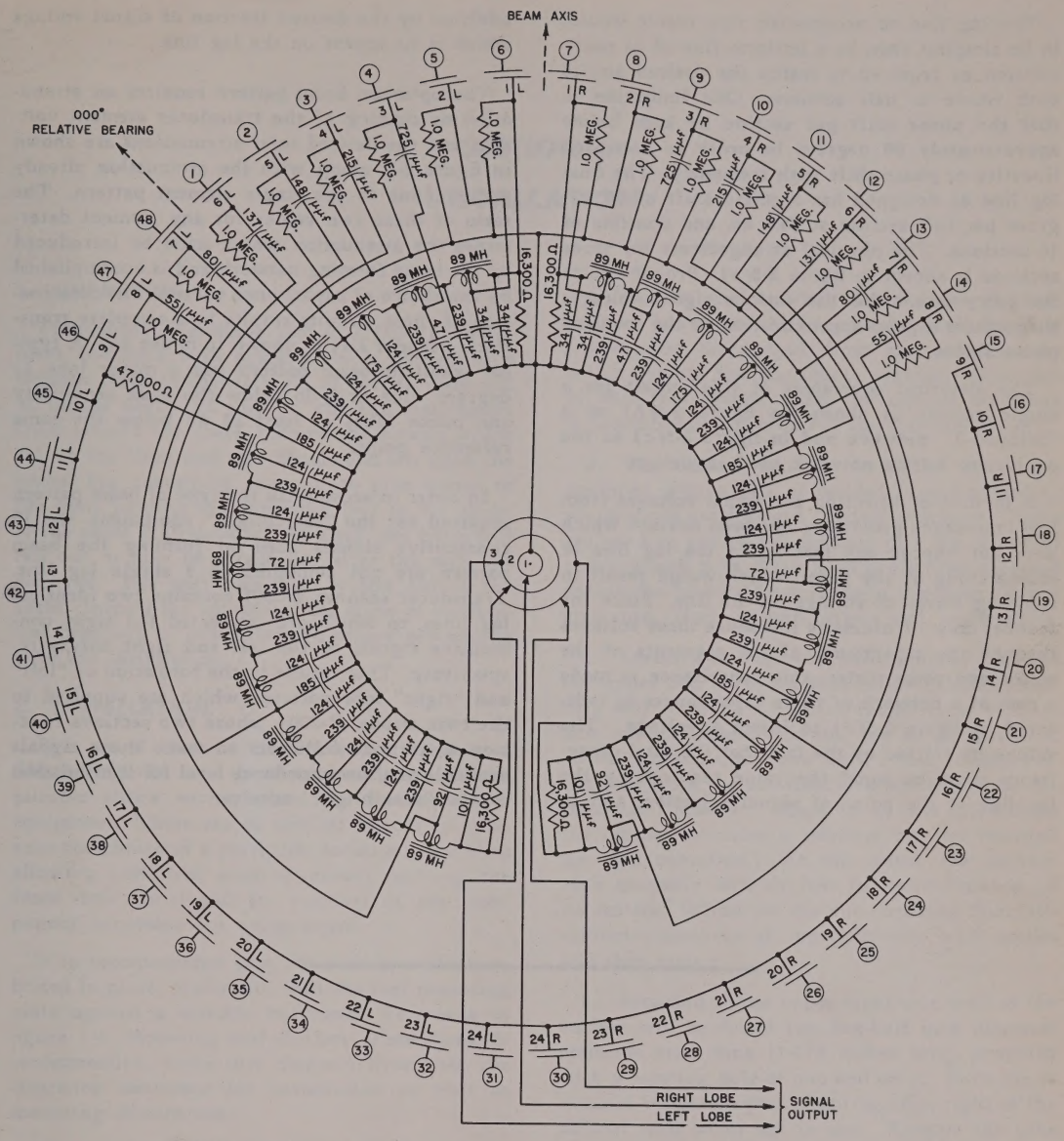


Figure 2-7. Transducer Scanner Schematic

(c) PHASING AND SHADING, THE LAG LINE.—The beam pattern formation can be analyzed by inspection of the voltages produced by the transducer elements, the required phasing and the choice of shading.

The first of these, involving the single element pattern, may be presented in several ways, one of which is shown in figure 2-4. From this it is evident that the total lagging phase shift for the signal from element number 1 is at least 680 degrees in order to bring it into phase with the signal from element number 8. The phase shift for the voltage from element number 2 is 31 degrees less than this, and so on, for the remaining elements.

The lag line to accomplish this result would, in its simplest case, be a uniform line of as many sections as required to match the desired angles with whole or half sections. One limitation is that the phase shift per section be kept below approximately 60 degrees in order to approach linearity of phase shift with frequency. The final lag line as designed has a phase shift of 52 degrees per full section at 25.5 kc, and consists of 14 sections. The physical arrangements for three sections is shown in figure 2-5*(a)*. Proper choice for entry points for the various signal voltages then allows a good approximation to the required phase shifts.

The electrical equivalent of this circuit for a single section is shown in figure 2-5*(b)* as a "bridged-T" network and in figure 2-5*(c)* as the equivalent lattice network used in design.

A method of injecting the signal voltages from low impedance generators has been devised which does not impose any loading of the lag line or mismatching at any point, which would result in standing waves of voltage on the line. Since the scanner must of necessity introduce these voltages through the capacitance of the segments of the stator and rotor plates, this capacitance is made a part of a network of three capacitances as indicated in figure 2-5*(d)* to inject a voltage. The values are related by the fact that the total capacitance must be equal the value required by the lag line at the point of signal injection, and in addition by the desired fraction of signal voltage which is to appear on the lag line.

The optimum beam pattern requires an attenuation or shading of the transducer element voltages and the desired total attenuations are shown in figure 2-6, along with the attenuation already present, due to the single element pattern. The ratio of these two values for any element determines the attenuation which must be introduced by the beam forming network and is accomplished by the choice of capacitance values. The combination of these circuits results in a complete transducer scanner circuit shown in figure 2-7. A typical resultant beam pattern has a major lobe 11 degrees wide at 6 db below the peak sensitivity and minor lobes at least 25 db below the same reference point.

In order to accomplish the type of beam pattern required for the "searchlight" equipment, the 16 consecutive signals used in forming the beam pattern are not combined in a single lag line. Transducer scanner Z-2301 contains two identical lag lines, to which are connected the eight consecutive signals of the left and right halves respectively. This results in the formation of "left" and "right" lobe patterns which are supplied to the twin triode, V-2304, whose two sections function as cathode followers to make these signals available at a low impedance level for transmission to the "searchlight" receiver.

SECTION 3
INSTALLATION

1. UNPACKING.

Transducer Simulator SM-58/UQS-T1 equipment complete with spare parts is packed in a wooden crate 48 inches high, 27 inches wide and 32 inches deep. To unpack, cut the steel bands from around the crate, remove the screws which secure the front and rear panels and slit open the sealed bag containing the unit to give access to the bolts holding the mounting feet to the skids. If the skids are raised off the deck, the bolts will fall out or may be driven out after the nuts are removed. The unit may then be slid out of the crate. Inspect the equipment for signs of mechanical breakage or other damage before proceeding with the installation.

2. INSTALLATION.

The actual location of Transducer Simulator SM-58/UQS-T1 will be determined by the applicable ship's wiring plans for the associated equipment. There are no critical factors to influence the choice of a particular location other than allowing sufficient area to permit opening the front door panel and for removal of any component necessary for replacement.

It is recommended that the unit be welded or bolted in place, preferably with the rear mounting plate against a suitable bulkhead. Reference to figure 3-4, Mounting and Outline Dimensions, is recommended, since this diagram illustrates the clearance necessary for installation as well as mounting dimensions.

After locating the position of the Transducer Simulator and securing it in place, the stop pins for the scanner assembly may be cut to proper length. This may be done as follows:

a. Remove the front door panel from the unit by loosening the six captive screws.

b. Unlatch the chassis in the upper portion of the cabinet and swing it outward to its stop position.

c. Loosen the knurled thumbscrew (located midway below the 23B terminal board) until it has become disengaged from the sub-structure which mounts the transducer scanner. (Removal of this thumbscrew from the cabinet structure is possible but not required for this operation.)

d. The lower cabinet structure has been equipped with a pair of welded lugs attached to the sides of its forward vertical members. These are used to secure the scanner rack by means of two 3/8 inch x 16 Allen head cap screws recessed within the forward boundaries of the main cabinet structure. Remove both screws and lockwashers.

e. Directly in front at a point midway between the upper and lower sections of the cabinet structure will be found a knurled thumbscrew with its axis vertical, similar to the one in paragraph *c.* above. Loosen this screw until it has become disengaged from the sub-structure which mounts the transducer scanner. (Removal of this screw from the cabinet structure is possible, but not required for this operation.) At this point, the scanner rack assembly will be free to move forward on its rollers. Withdraw the sub-structure from the cabinet a distance of approximately 1-1/2 inches and then stop.

f. Attached to the upper right side wall of the cabinet will be found two one-half inch diameter stainless steel pins 11-3/4 inches long, provided with a locating hole at one end only. Each pin is secured between a pair of spring clips rigid to the cabinet wall when not in use. Remove the pins from their mountings.

g. Attached to the forward vertical angles of the sub-structure will be found a pair of jack screws with knurled knobs, whose axes are vertical to the structure. Below each jack screw will be found a single spring clip rigid to the structure. At each forward and lower corner of the scanner rack a hole has been provided to accommodate the pins. Insert the pins through the holes pro-

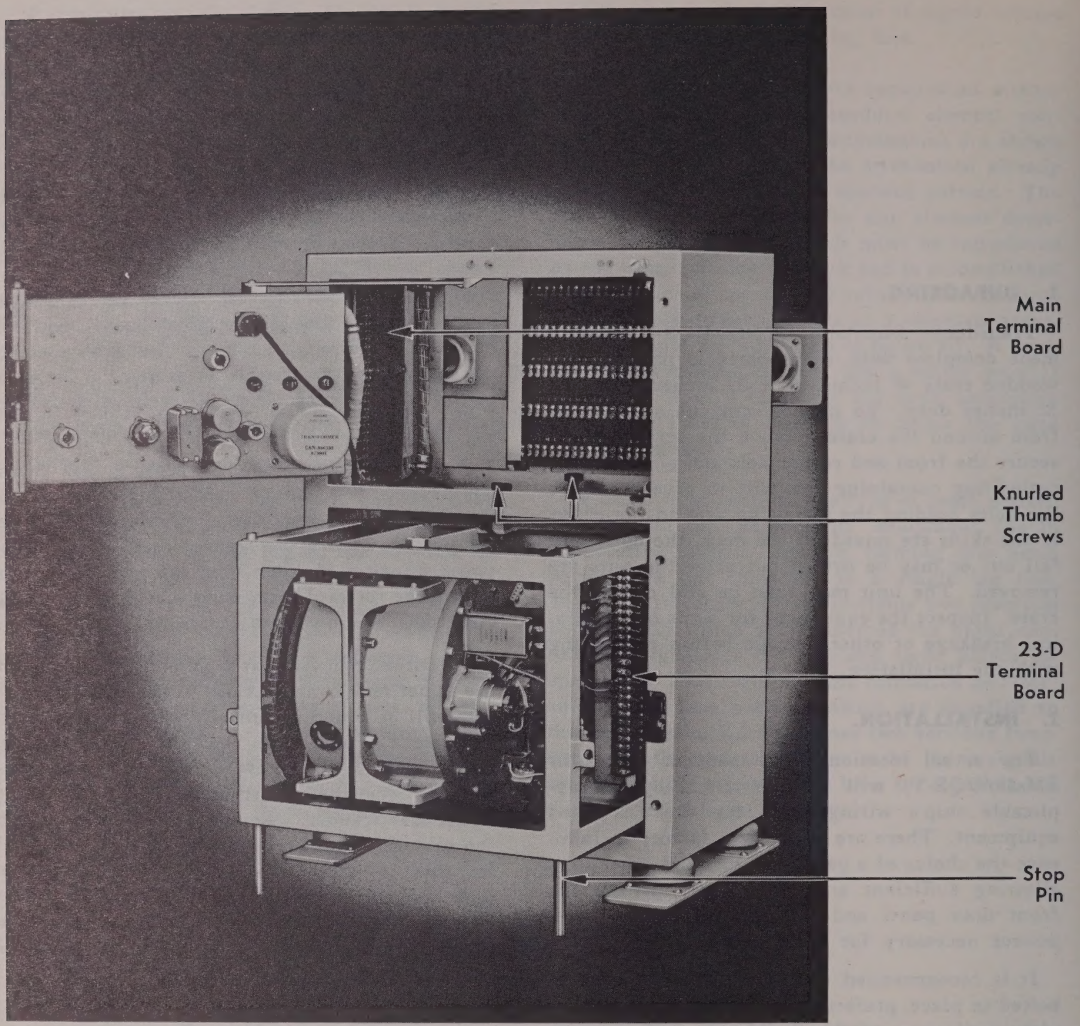


Figure 3-1. Transducer Simulator, Showing Main Terminal Board

vided, with their recessed ends pointing upward. Snap each pin in its respective spring clip and note that the end of the pin containing the bored hole appears directly under the center of the jack screw. Operate the jack screw downward until it is in mesh with the bored hole in the support pin, and the pin has been driven downward against the friction of the spring clip to the point where it just rests on the base plate of the shock mounted foot assembly, supporting the main structure of the cabinet. Cut the support pins to the length required for the above condition to obtain.

h. After all preceding steps have been performed, the sub-structure may be withdrawn until the mechanical stops have been reached. This operation may best be performed by physically supporting the load by hand gripping the forward horizontal cross-member of the sub-structure at the upper end, and pulling forward until the limit is reached. The support pins referred to above merely act as temporary foot extensions for supporting the sub-structure from the deck. At this point it will be noted that the knurled thumb-screw at the front, midway between the upper

and lower sections of the cabinet, can be re-engaged with the sub-structure at its rear support point. This should be done to provide stability to the assembly when in the opened position.

i. Proceed with the installation in accordance with the applicable ship's plans. After completing all internal connections the cabinet structure is to be grounded to the ship by suitable copper braid, connection being made to a grounding stud at the bottom of the left side of the cabinet.

3. INITIAL TESTS AND ADJUSTMENTS.

It is assumed that all units of the associated equipment are correctly interconnected in accordance with the ship's type plans and in proper operating condition. It is also assumed that the singlephase, 60 cycle power source maintains a value of 117 volts, plus or minus ten percent at the equipment incoming power terminals.

a. APPLYING EQUIPMENT POWER.

Equipment power is controlled directly from the associated equipment. Perform the necessary functions in order to apply power to the Transducer Simulator.

(1) POWER ON OBSERVATIONS.—The application of power to the equipment will be indicated by illumination of the "POWER" lamp on the front door panel.

(2) ALIGNMENT CHECK.—Set the azimuth dial on the "searchlight" equipment to 000 degrees bearing and observe the transducer scanner rotor position through the lucite covered port and verify that the rotor and stator index marks are aligned, as shown in figure 3-2.

4. CONVERSION TO SINGLE SPEED SYSTEM.

a. Remove resistor R-2315 from the pin 2 and 4 terminals of terminal post No. 8 (see figures 4-5 and 4-7).

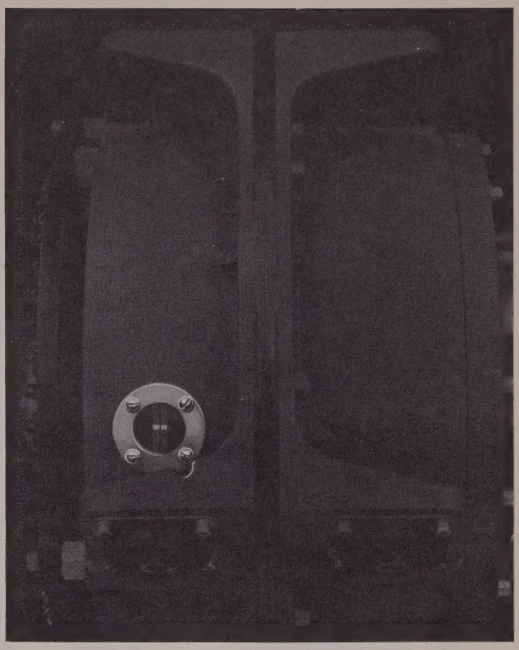
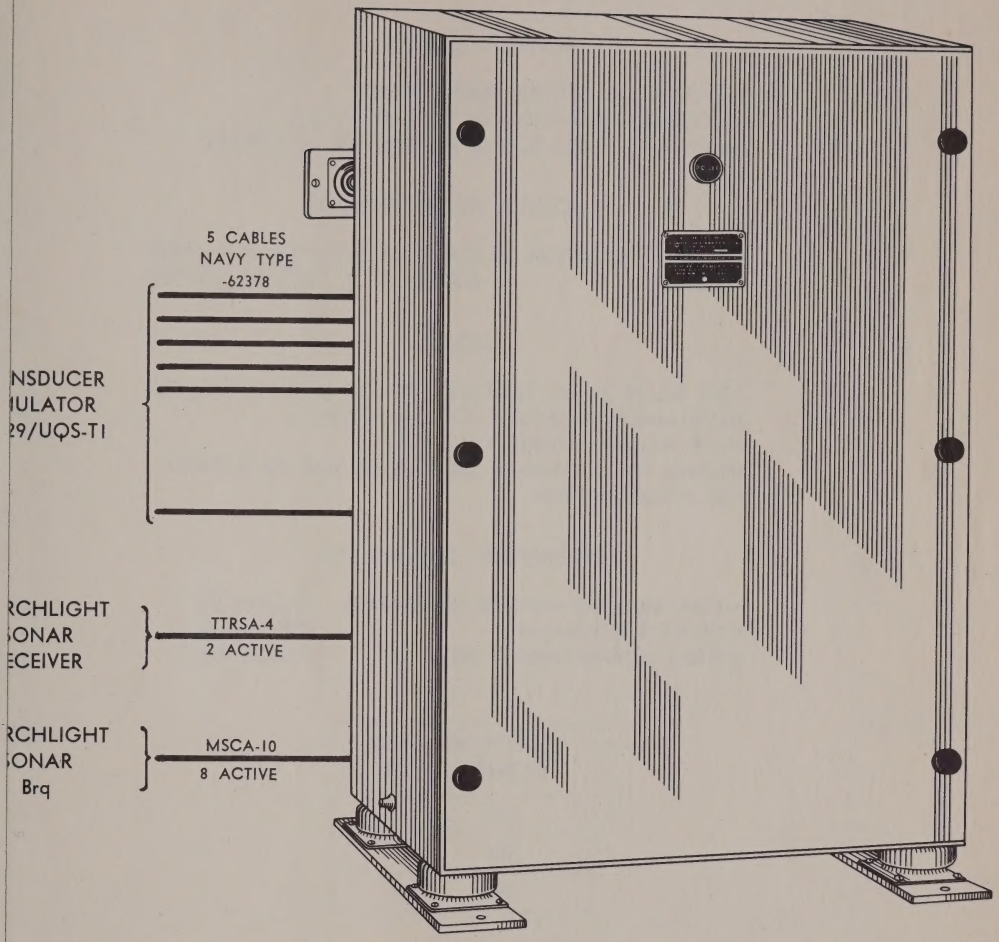


Figure 3-2. Transducer Scanner Rotor and Stator Alignment

b. Remove resistor R-2314. (See figure 4-6.)

c. Remove the 23D-3 lead from terminal 5 of MG-2301 and connect to junction point D. (See figure 4-6.)

d. Connect a lead from pin 5 of MG-2301 to junction point J, (see figure 4-6). The unit may now be operated as a single speed system using only the 1^X (B-2302) input. No input connections should be made to the 36^X (B-2301) synchro.



TRANSDUCER SIMULATOR
SM-58/UQS-T1

Figure 3-3. System Pictorial

RESTRICTED
NAVSHIPS 91824(A)

POWER SUPPLY

117 VOLTS, 60 CYCLES, SINGLE PHASE
ALLOWABLE VARIATION IN VOLTAGE ±10%
ALLOWABLE VARIATION IN FREQUENCY ±2 CYCLES

POWER REQUIREMENTS

NORMAL OPERATION	54 WATTS AT 94%	POWER FACTOR
SECURED	0 WATTS AT 0	POWER FACTOR

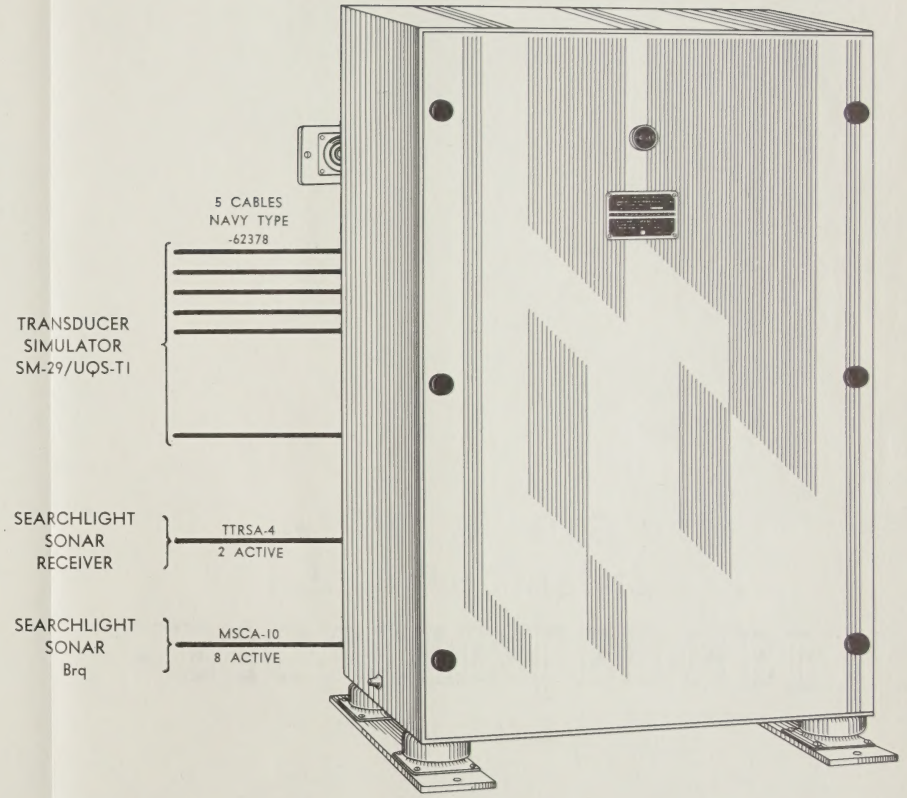
NOTES

KEEP CRATE IN AN UPRIGHT POSITION UNTIL UNPACKED
NOTE ARROW POINTING TO TOP OF CRATE
NOTE WEIGHT MARKED ON CRATE
DO NOT USE A HAMMER OR A PINCH BAR TO UNPACK
USE A SCREWDRIVER

REFERENCE DRAWINGS

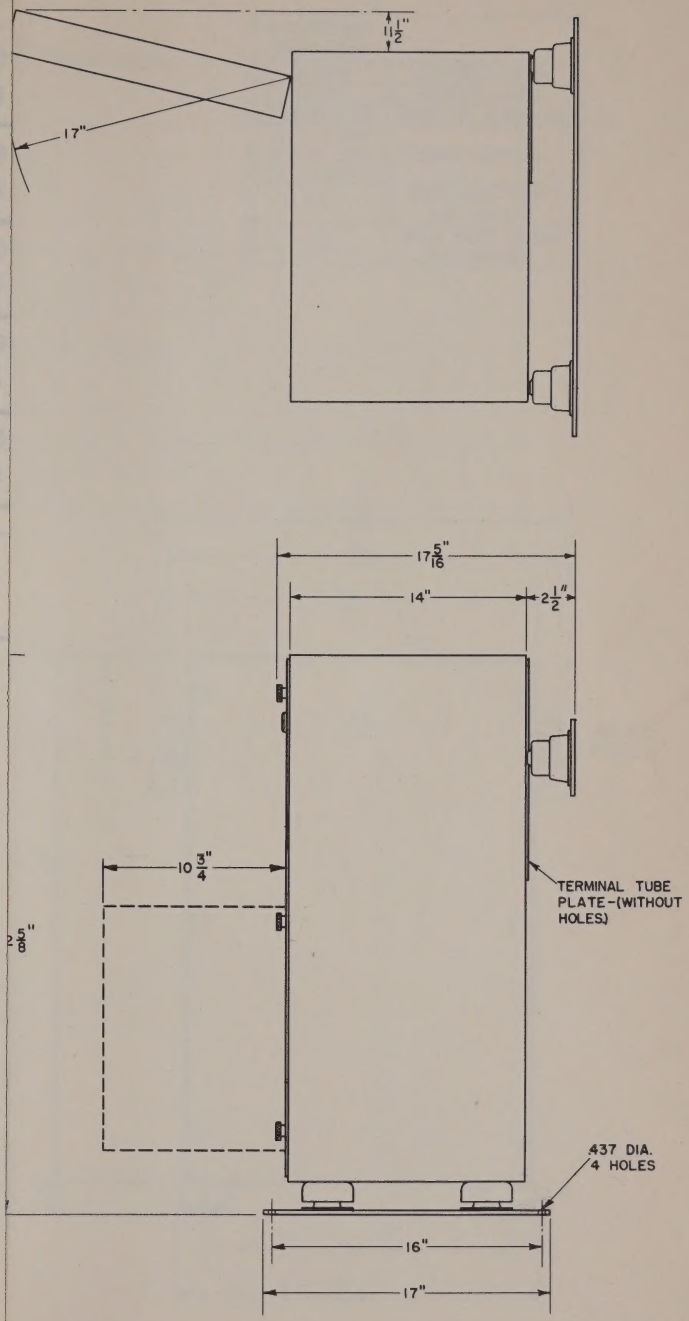
MOUNTING AND OUTLINE DIMENSIONS	FIGURE 3-4
COMPLETE SCHEMATIC	FIGURE 3-5
SYSTEM INTERCONNECTIONS	FIGURE 3-6

ELECTRON TUBE COMPLEMENT	
6V6	1
6X4	1
12AU7	2



TRANSDUCER SIMULATOR
SM-58/UQS-T1

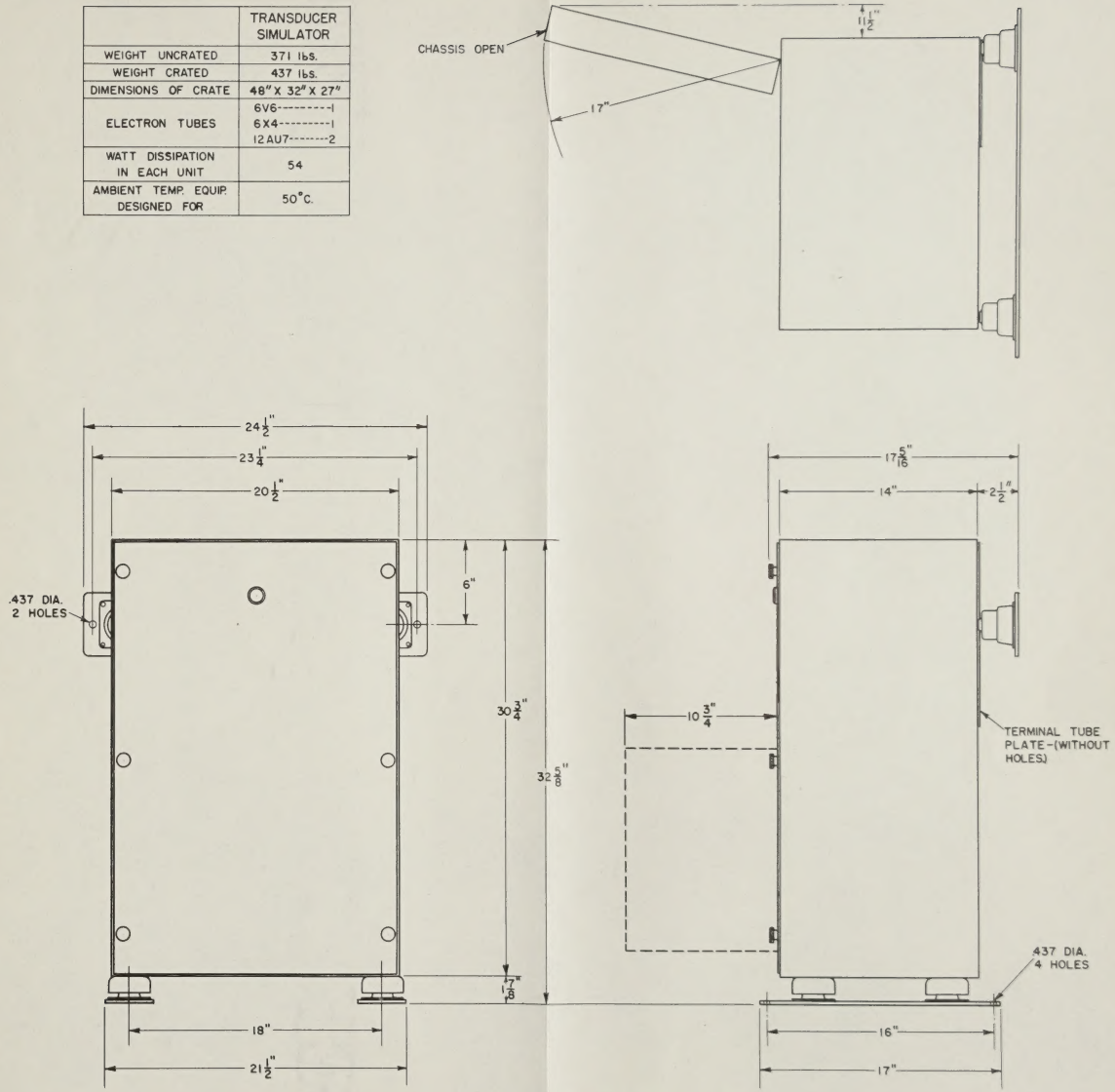
Figure 3-3. System Pictorial



UCER SIMULATOR
1-58/UQS-TI

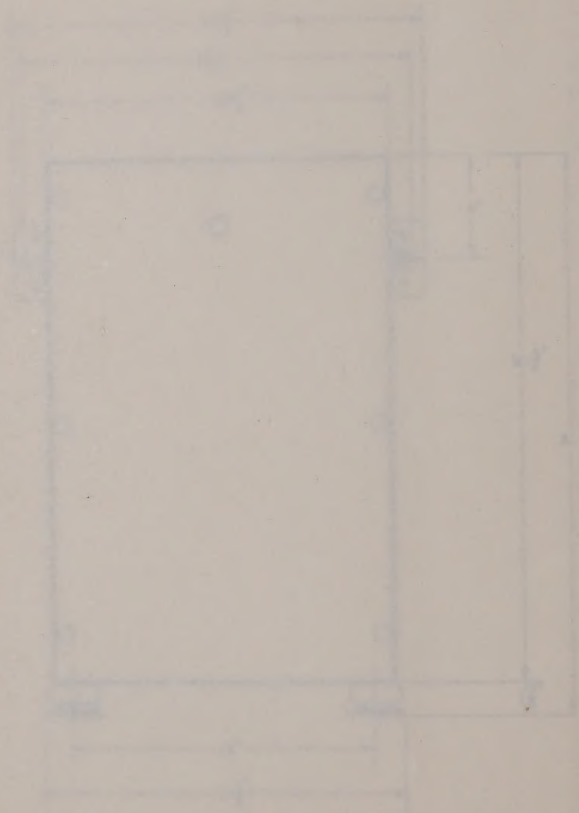
Figure 3-4. Mounting and Outline Dimensions

	TRANSDUCER SIMULATOR
WEIGHT UNCRATED	371 lbs.
WEIGHT CRATED	437 lbs.
DIMENSIONS OF CRATE	48" X 32" X 27"
ELECTRON TUBES	6V6---------1 6X4---------1 12AU7--------2
WATT DISSIPATION IN EACH UNIT	54
AMBIENT TEMP. EQUIP. DESIGNED FOR	50°C.



TRANSDUCER SIMULATOR
SM-58/UQS-T1

Figure 3-4. Mounting and Outline Dimensions



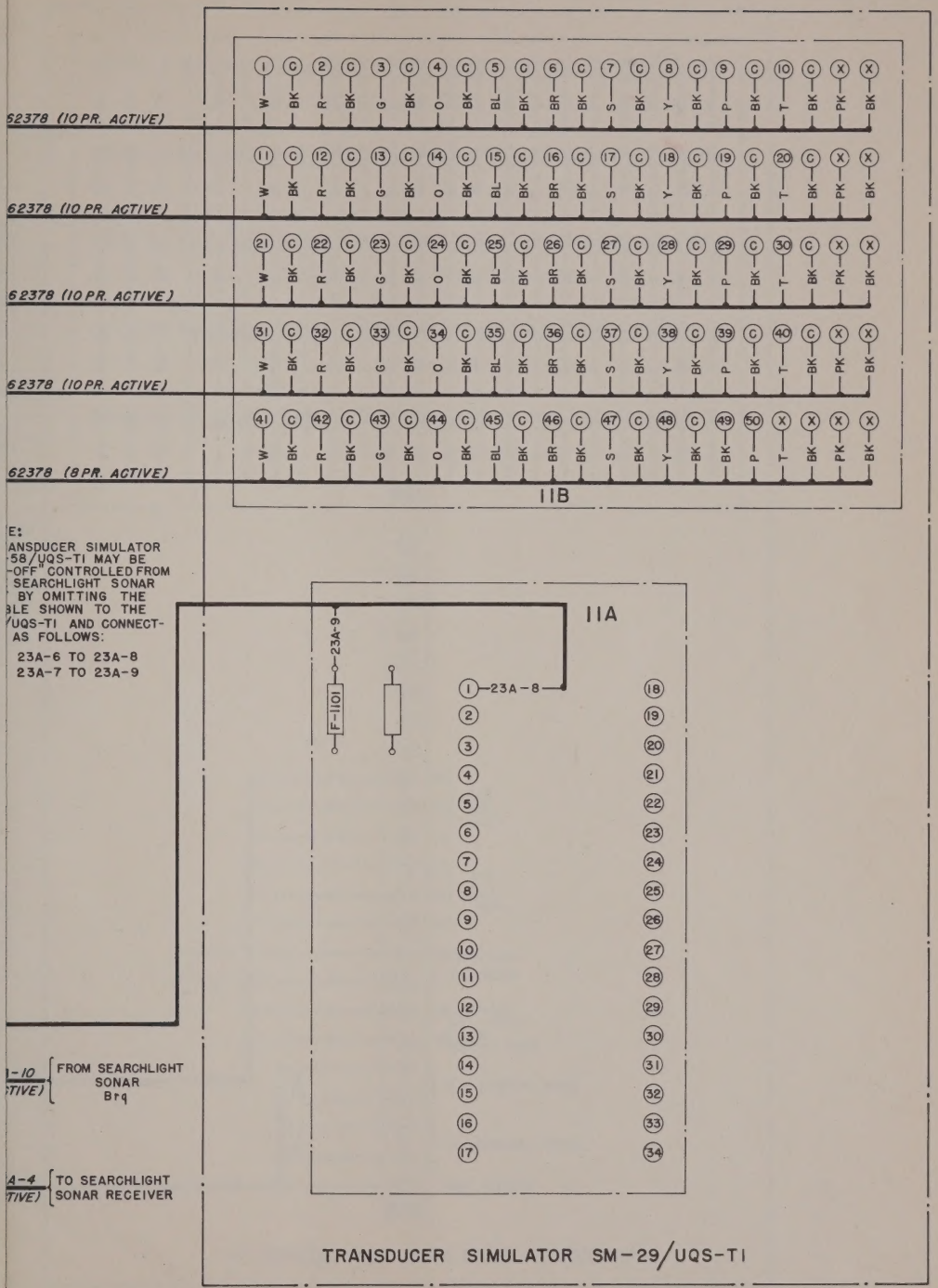
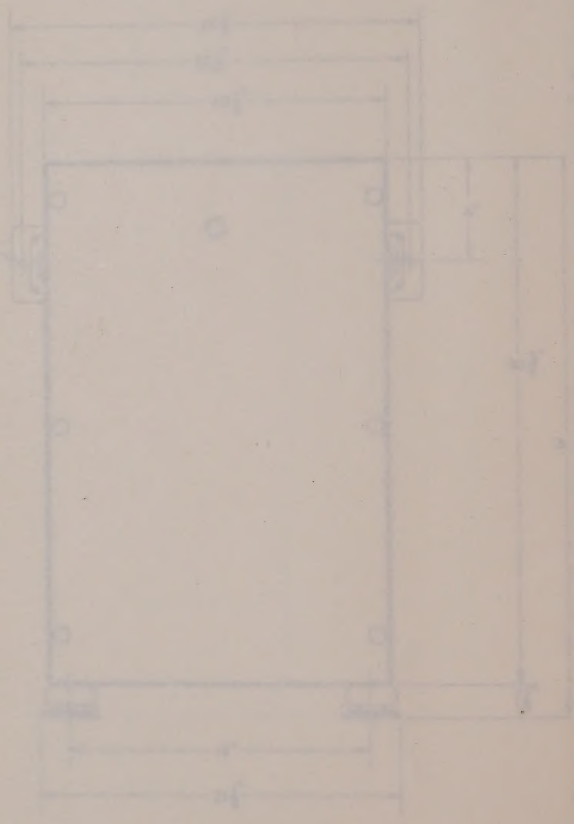


Figure 3-6. System Interconnections



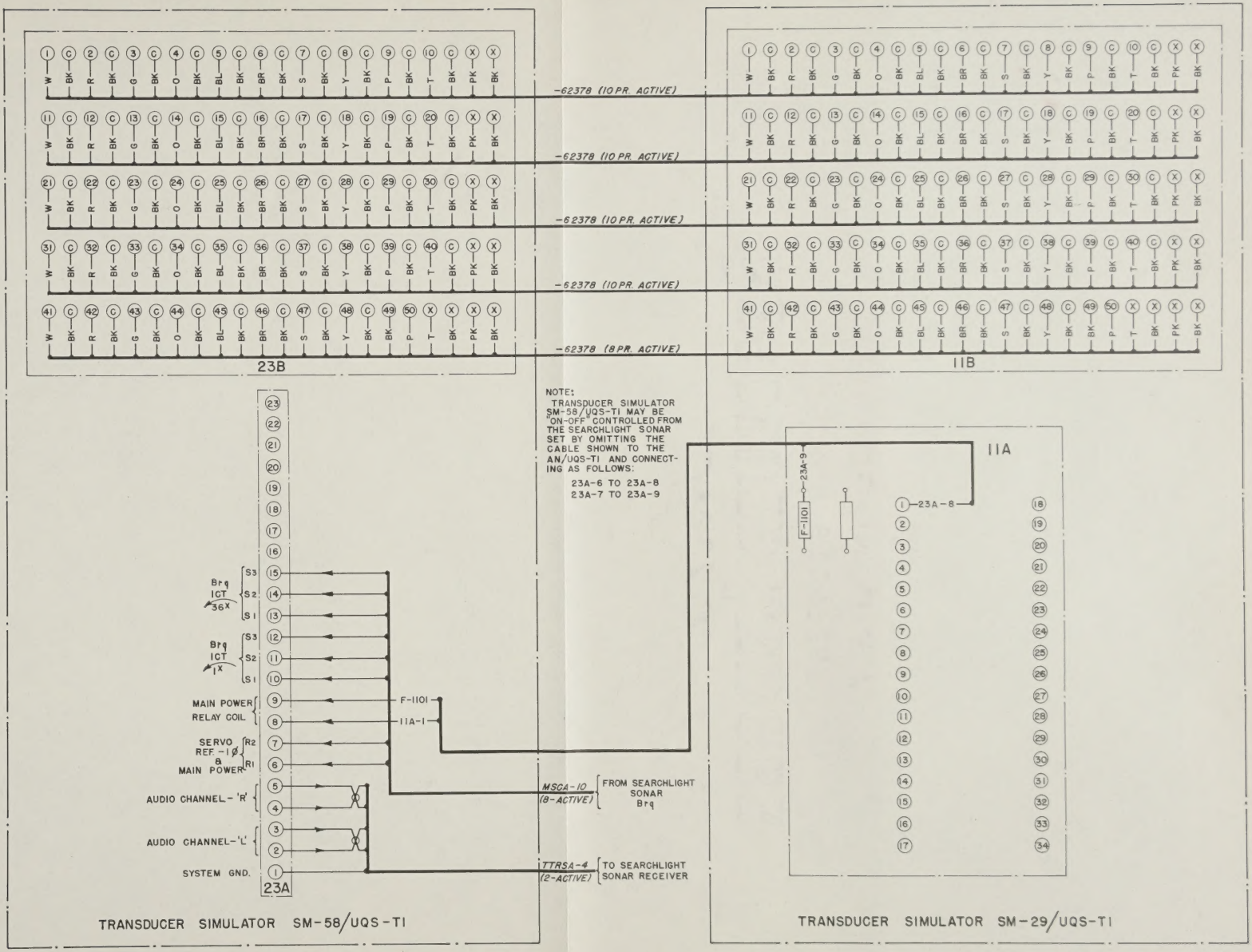
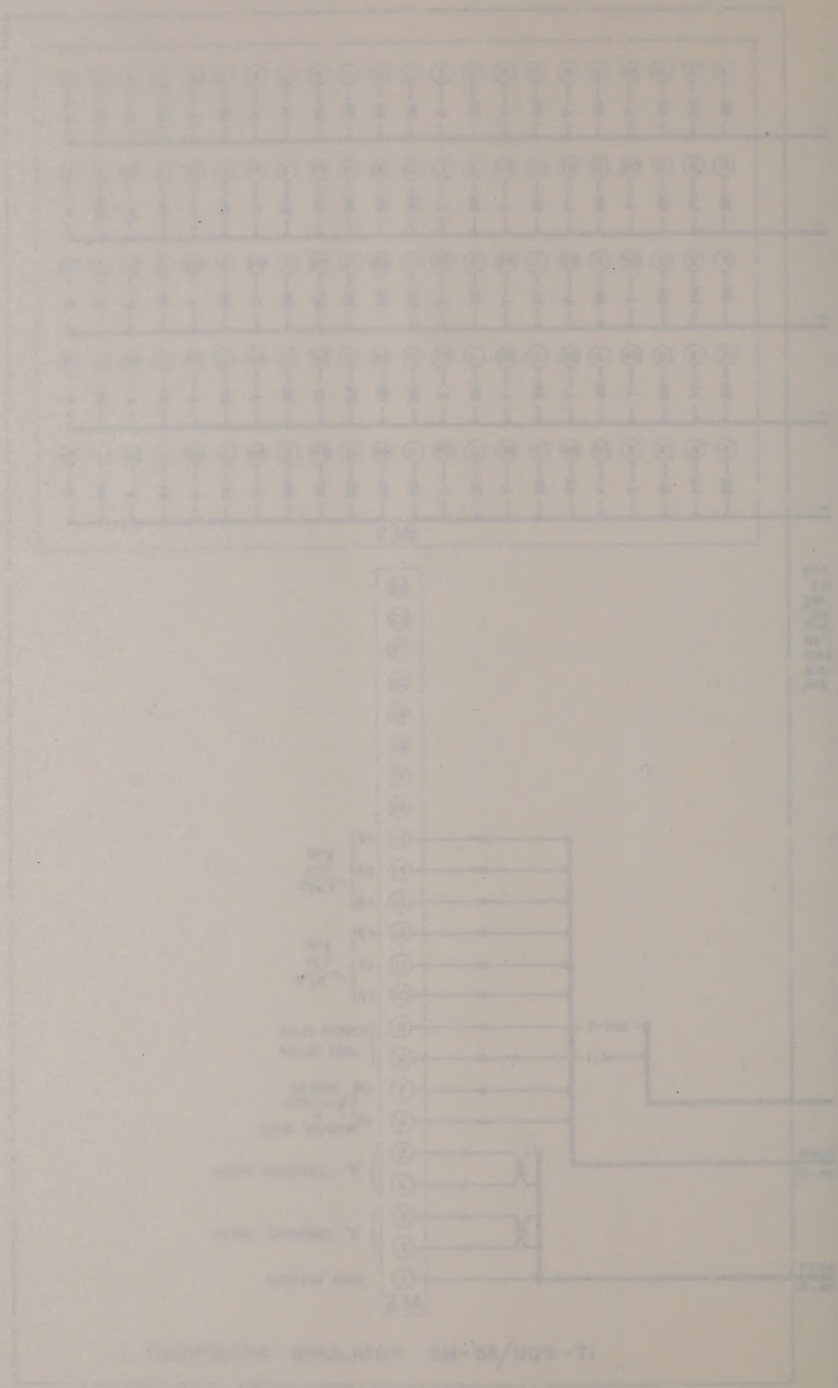


Figure 3-6. System Interconnections



FAILURE REPORTS

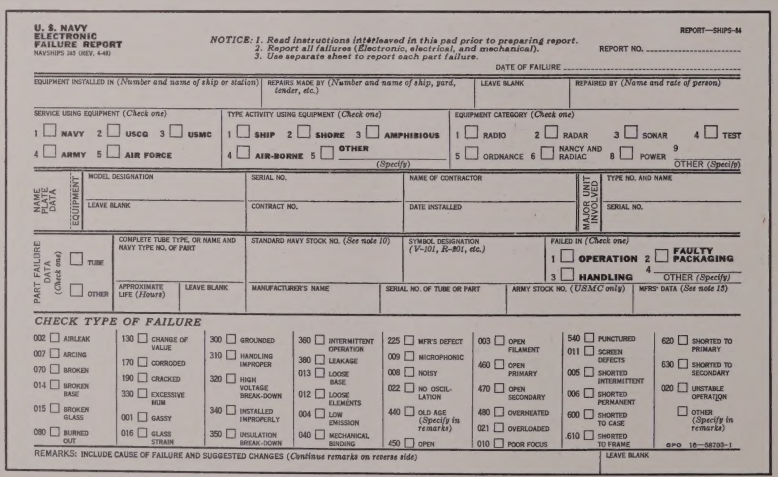
A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest district printing and publication office.



U. S. NAVY
ELECTRONIC
FAILURE REPORT
NAVSHIPS 383 (REV. 4-48)

NOTICE: 1. Read instructions interleaved in this pad prior to preparing report.
2. Report all failures (Electronic, electrical, and mechanical).
3. Use separate sheet to report each part failure.

REPORT—SHIPS-M

REPORT NO. _____

DATE OF FAILURE _____

EQUIPMENT INSTALLED IN (Number and name of ship or station) | REPAIRS MADE BY (Number and name of ship, yard, tender, etc.) | LEAVE BLANK | REPAIRED BY (Name and rate of person)

SERVICE USING EQUIPMENT (Check one)
1 ☐ NAVY 2 ☐ USCG 3 ☐ USMC
4 ☐ ARMY 5 ☐ AIR FORCE

TYPE ACTIVITY USING EQUIPMENT (Check one)
1 ☐ SHIP 2 ☐ SHORE 3 ☐ AMPHIBIOUS
4 ☐ AIR-BORNE 5 ☐ OTHER (Specify)

EQUIPMENT CATEGORY (Check one)
1 ☐ RADIO 2 ☐ RADAR 3 ☐ SONAR 4 ☐ TEST
5 ☐ ORDNANCE 6 ☐ NANCY AND RADIAC 8 ☐ POWER 9 OTHER (Specify)

NAME PLATE DATA EQUIPMENT
MODEL DESIGNATION | SERIAL NO. | NAME OF CONTRACTOR
LEAVE BLANK | CONTRACT NO. | DATE INSTALLED

MAJOR UNIT INVOLVED
TYPE NO. AND NAME
SERIAL NO.

PART FAILURE DATA (Check one) ☐ TUBE ☐ OTHER
COMPLETE TUBE TYPE, OR NAME AND NAVY TYPE NO. OF PART | STANDARD NAVY STOCK NO. (See note 10) | SYMBOL DESIGNATION (V-101, Z-801, etc.)
APPROXIMATE LIFE (Hours) | LEAVE BLANK | MANUFACTURER'S NAME | SERIAL NO. OF TUBE OR PART | ARMY STOCK NO. (USMC only) | MFRS' DATA (See note 15)

FAILED IN (Check one)
1 ☐ OPERATION 2 ☐ FAULTY PACKAGING
3 ☐ HANDLING 4 ☐ OTHER (Specify)

CHECK TYPE OF FAILURE

002 ☐ AIRLEAK
007 ☐ ARCING
070 ☐ BROKEN
014 ☐ BROKEN BASE
015 ☐ BROKEN GLASS
080 ☐ BURNED OUT
130 ☐ CHANGE OF VALUE
170 ☐ CORRODED
190 ☐ CRACKED
330 ☐ EXCESSIVE RUN
001 ☐ GASSY
016 ☐ GLASS STRAIN
300 ☐ GROUNDED
310 ☐ HANDLING IMPROPER
320 ☐ HIGH VOLTAGE BREAK-DOWN
340 ☐ INSTALLED IMPROPERLY
350 ☐ INSULATION BREAK-DOWN
360 ☐ INTERMITTENT OPERATION
380 ☐ LEAKAGE
013 ☐ LOOSE BASE
012 ☐ LOOSE ELEMENTS
004 ☐ LOW EMISSION
040 ☐ MECHANICAL BINDING
225 ☐ MFR'S DEFECT
009 ☐ MICROPHONIC
008 ☐ NOISY
022 ☐ NO OSCILLATION
440 ☐ OLD AGE (Specify in remarks)
450 ☐ OPEN
003 ☐ OPEN FILAMENT
460 ☐ OPEN PRIMARY
470 ☐ OPEN SECONDARY
480 ☐ OVERHEATED
021 ☐ OVERLOADED
010 ☐ POOR FOCUS
540 ☐ PUNCTURED
011 ☐ SCREEN DEFECTS
005 ☐ SHORTED INTERMITTENT
006 ☐ SHORTED PERMANENT
600 ☐ SHORTED TO CASE
610 ☐ SHORTED TO FRAME
620 ☐ SHORTED TO PRIMARY
630 ☐ SHORTED TO SECONDARY
020 ☐ UNSTABLE OPERATION
☐ OTHER (Specify in remarks)

REMARKS: INCLUDE CAUSE OF FAILURE AND SUGGESTED CHANGES (Continue remarks on reverse side)
LEAVE BLANK

GPO 16—58703-1

SECTION 4
MAINTENANCE

1. OPERATION.

Transducer Simulator SM-58/UQS-T1 requires no operator manipulation since its functions are controlled entirely by the associated equipment.

2. EMERGENCY MAINTENANCE.

Notice To Operators

Operators shall not perform any of the following emergency maintenance procedures without proper authorization.

a. PERMANENTLY ALIVE ELECTRICAL CIRCUITS.—Since the equipment must derive its power from an external source, as well as having external connections for some electrical information and control lines, there will be circuits which are alive, depending upon the switching of the associated equipment. These circuits include:

Servo Reference Single-phase and Main Power	23A-6 and 23A-7
Main Power Relay Control	23A-8 and 23A-9
Brq 1^X	23A-10, 23A-11 and 23A-12
Brq 36^X	23A-13, 23A-14 and 23A-15

The servo reference singlephase power may be confined to its cabinet termination by removing fuses F-2301 and F-2302, on the signal and servo amplifier chassis. The main power for relay control, the synchro Brq 1^X and 36^X orders may be removed only by de-energizing the source from which these are supplied.

b. FUSE FAILURE. — All active equipment fuses are located on the signal and servo amplifier chassis while spare fuses are mounted in clips on the upper right side wall of the cabinet.

NOTE: Never replace a fuse with one of a higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been corrected.

3. PERFORMANCE TESTS.

For the purpose of checking the performance of the transducer scanner it will be sufficient to measure signal levels and observe the beam pattern for a signal to only one element of the system.

a. TRANSDUCER SCANNER CHECK.

Connect a signal generator to terminal 23B-1 and its "C" terminal and introduce a signal of 0.42 volts at 25.5 kilocycles (see figure 4-5). The output as measured with an electronic voltmeter (Multimeter ME-25/U, or equivalent) at pin 2 or pin 7 of V-2304 and ground, should be approximately 14 millivolts when the rotor and stator marks on the transducer scanner are in alignment. Under the same conditions, the output from the cathodes of V-2304, pin 3 or pin 8 and ground should be approximately 8 millivolts and the balanced output between terminals 23A-2 and 23A-3 or 23A-4 and 23A-5 should read approximately 3.3 millivolts.

If the lag line circuits, internal to the transducer scanner, are functioning properly, the change in signal output with relative bearing should approximate the accompanying table, if a voltage is supplied between terminal 23B-1 and its corresponding "C" terminal and the output at 000 degrees relative is taken as unity.

000	degrees or 7.5	degrees	1.00
352	degrees or 15	degrees	0.92
345	degrees or 22.5	degrees	0.83
337.5	degrees or 30	degrees	0.71
330	degrees or 37.5	degrees	0.60
322.5	degrees or 45	degrees	0.52
315	degrees or 52.5	degrees	0.42
307.5	degrees or 60	degrees	0.32

NOTE: The above readings serve as a guide only since duplication of test facilities may differ by enough to provide false readings if the load from the test circuit introduces standing waves to the lag line circuits.

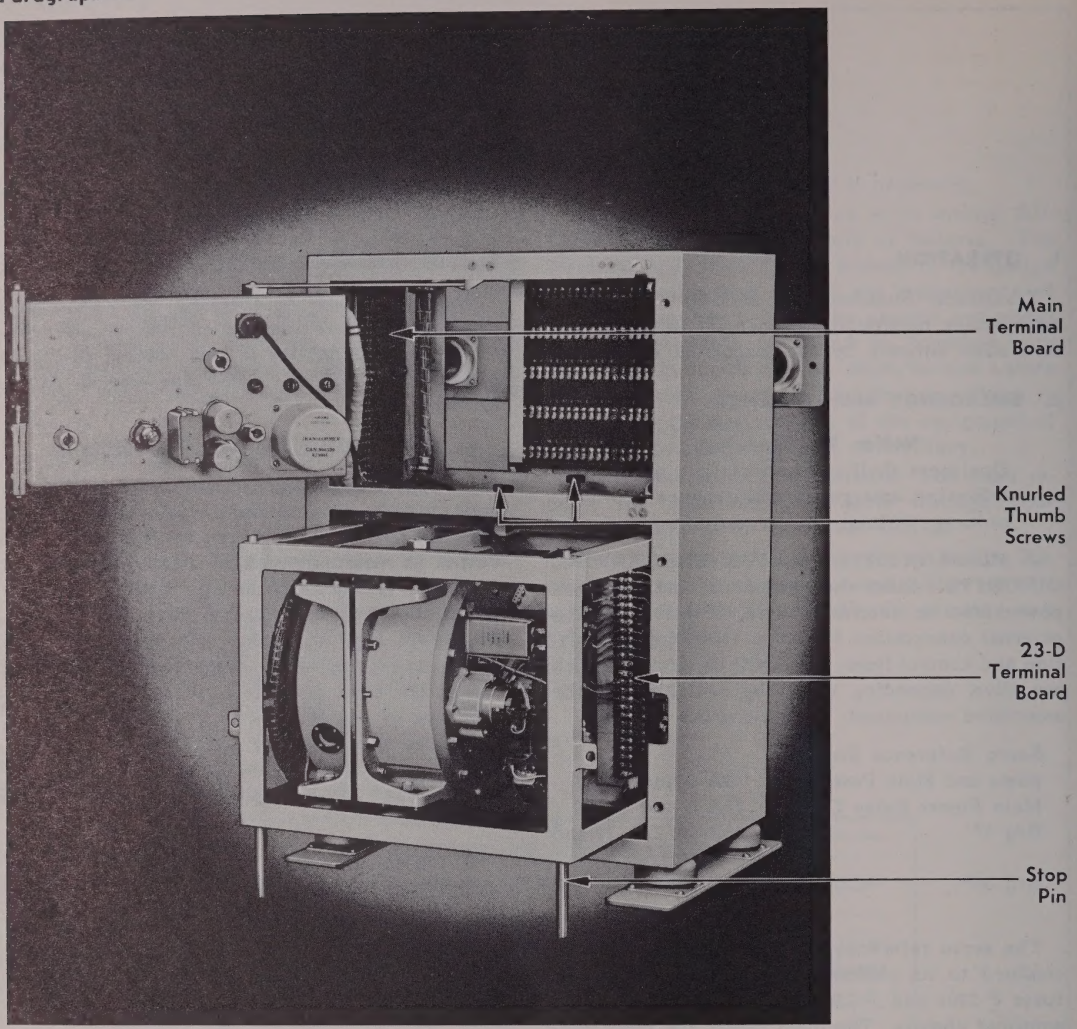


Figure 4-1. Transducer Simulator, Scanner Rack Withdrawn

4. CORRECTIVE MAINTENANCE.

Need for maintenance of an equipment is invariably evidenced by the inability of the apparatus to perform one or more specific functions properly. Transducer Simulator SM-58/UQS-T1 has a simple relationship to its associated equipment, yet the accurate functioning of the entire system is dependent upon proper operation of the equipment.

Although repair can be effected by the procedures specified, it should be evident that intelligent maintenance requires thorough familiarity with the theory of operation of the equipment, as described in Section 2. The maintenance procedure is broken down into the following operations.

Trouble Shooting (Paragraph 4*a*)
Component Replacement (Paragraph 4*b*)
Equipment Adjustment (Paragraph 4c)
Lubrication (Paragraph 4*d*)

Identification of components in the equipment is accomplished, where practicable, by means of symbol designations near the corresponding components. Space limitations inside the signal and servo amplifier chassis do not permit the use of

this system throughout. A component map is conveniently placed on the inside of the chassis cover plate to show locations of all the unmarked components mounted on this chassis. As a further check, components may be readily identified by referring to figure 4-4.

The actual wiring scheme of the Transducer Simulator is provided in two diagrams, figures 4-6 and 4-7. Use of these diagrams is indicated whenever any extensive component replacement or wiring is required. The diagrams show actual location of components as well as the placement of wiring for the equipment.

a. TROUBLE SHOOTING.

Failures of Transducer Simulator SM-58/UQS-T1 fall into two definite categories, operational and calibrative. Operational failures will be evidenced by the inability of the equipment to perform definite functions. Calibrative failures will be evidenced by the inaccuracy of the equipment to respond to its functions. Usually whenever a major component such as a synchro is replaced, recalibration is recommended.

(1) OPERATIONAL FAILURES.—Operational failures of the equipment can best be diagnosed by use of a tabulated list of faults, as shown below, which will enable the maintenance technician to localize the failure.

(2) TABULATION OF FAULTS FOR TRANSDUCER SIMULATOR SM-58/UQS-T1.

(a) LINE POWER FAILURE. — Check for singlephase, 117 volts, 60 cycles at the following terminals:

23A-6 to 23A-7 23C-6 to 23C-7

(b) FUSE FAILURE.—Fuses F-2301 and F-2302.

1. Load on convenience outlets, J-2301 and J-2302 sufficient to burn out fuses.

2. Loose clip on convenience outlets J-2301 and J-2302 permitting short on line.

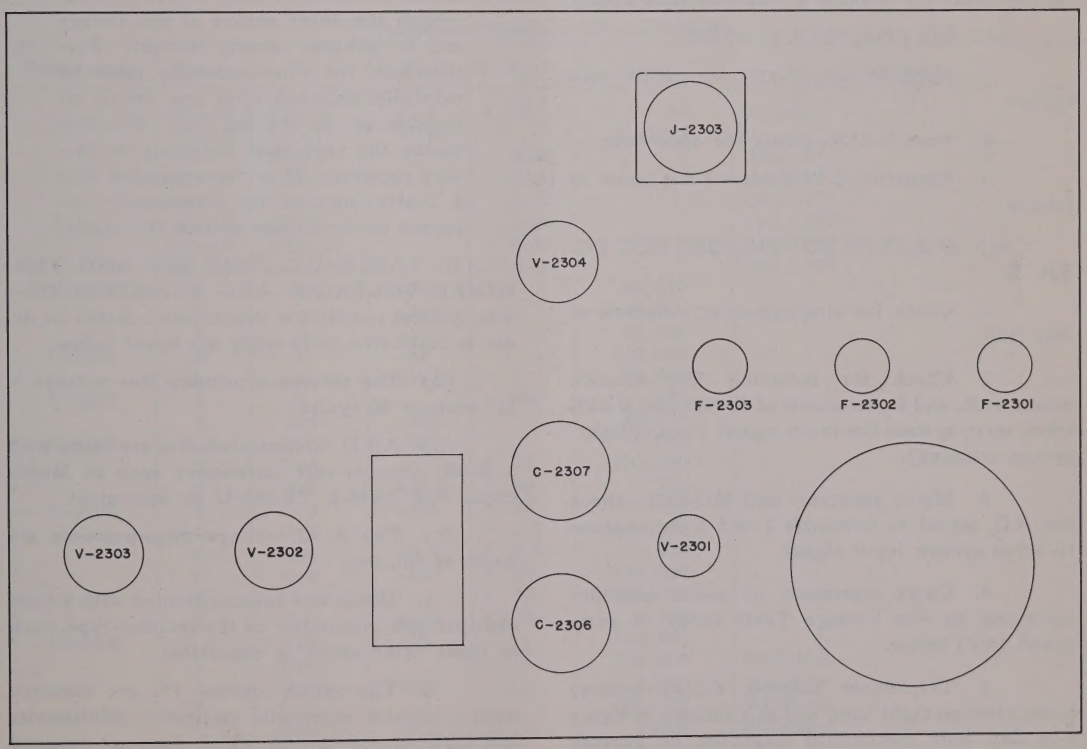


Figure 4-2. Removable Components, Signal and Servo Amplifier Chassis

3. POWER indicator lamp, I-2301 — shorted.

4. Relay K-2301—mechanical failure or shorted.

5. Motor generator unit MG-2301 — check motor coil and connections for either mechanical or electrical failure with associated shorting.

6. Capacitor C-2302—check for short.

7. Motor generator unit MG-2301—check generator portion for mechanical or electrical failure of excitation coil and associated shorting.

8. Capacitor C-2301—check for short.

(c) NO HEATER VOLTAGE.

1. Transformer T-2301—check for open winding or loose connection.

2. Fuse F-2303—check for open fuse or possible short at fuse holder.

3. Tube Sockets—check for mechanical failure resulting in open or short at tube socket.

(d) NO POSITIVE POWER.

1. Rectifier tube V-2301—check for tube failure.

2. Fuse F-2304—check for open fuse.

3. Capacitor C-2306—check for short or failure.

(e) SCANNER ROTOR DOES NOT ROTATE.

1. Check for singlephase at terminals of MG-2301.

2. Check for incoming Brq synchro orders at R_1 and R_2 terminals of B-2301 and B-2302 when servo system has input signal ("searchlight" system training).

3. Motor generator unit MG-2301—check for A.C. signal to terminals 2 and 4 in response to servo system input signal.

4. Check operation of servo amplifier according to Pin Voltage Table listed in paragraph 4*a(3)* below.

5. Transducer Scanner Z-2301—remove cover plate on right hand end bell (shown in figure 4-3) and note mechanical condition of gearing from motor-generator shaft to scanner rotor shaft.

(f) INTERRUPTION OF WATER SIGNAL.

1. Tube V-2304—check or replace.

2. Check circuit associated with V-2304 against Pin Voltage Table listed in paragraph 4*a(3)*, below.

3. Transformers T-2302 and T-2303 — check windings for continuity.

4. Plug P-2303—check for continuity between plug ends and scanner brushes. If a water signal is non-existent or interrupted after above checks and the associated equipment is functioning properly, it may be assumed that the failure is in the transducer scanner lag line.

NOTE: Any lag line failure may be extremely difficult to diagnose since electrical failure may be anything from a complete open circuit to simple derangements involving a single element. In any event, repair in the field is impossible since elaborate bridge measurements of the circuit are required to establish the exact nature of the failure and to indicate remedy thereof. Furthermore, the rotor assembly must be carefully balanced after any repair or replacement in the lag line. For this reason the unit must obviously be factory repaired. It is recommended that a faulty scanner be immediately returned to the supply system for repair.

(3) TABLE OF TUBE PIN AND TERMINAL VOLTAGES AND RESISTANCES.— The general conditions which must obtain in order to make this table apply are listed below:

(a) The reference primary line voltage is 117 volts at 60 cycles.

(b) All D. C. measurements are made with a 20,000 ohm-per-volt instrument such as Multimeter AN/PRM-4, TS-352/U or equivalent.

(c) The A. C. voltage measurements are made as follows:

1. Unmarked values obtained with a 1,000 ohm-per-volt instrument of the rectifier type, such as those listed above or equivalent.

2. The values marked (*) are obtained with a suitable electronic voltmeter (Multimeter ME-25/U or equivalent) which does not respond to a D. C. component.

(d) All A. C. and D. C. measurements (except resistance measurements) are made with normal power supplied to the equipment except as modified by the "Remarks" column of Table 4-1.

b. COMPONENT REPLACEMENT.

All components of the Transducer Simulator are readily accessible on either the hinged chassis or the track and roller mounted sub-structure containing the transducer scanner. The chassis mounted components are accessible from two sides without the necessity of dismounting the chassis from the cabinet. For all maintenance purposes the scanner rack may be withdrawn sufficiently to permit easy removal or replacement of any component external to the scanner.

(1) EXTRACTION OF TRANSDUCER SCANNER FROM RACK.

(a) Loosen six captive thumbscrews and remove the front door panel from the cabinet.

(b) Unlatch the chassis in the upper portion of the cabinet and swing it outward to its stop position.

(c) Loosen the knurled thumbscrew (located midway below the 23B terminal board) until it becomes disengaged from the sub-structure which mounts the transducer scanner.

(d) The lower cabinet structure has been equipped with a pair of welded lugs attached to the sides of its forward vertical members. These are used to secure the scanner rack by means of two 3/8 inch x 16 Allen head cap screws recessed within the forward boundaries of the main cabinet structure. Remove both screws and lockwashers.

(e) Directly in front at a point midway between the upper and lower sections of the cabinet structure will be found a knurled thumbscrew with its axis vertical, similar to the one in paragraph *(c)* above. Loosen this screw until it has

TABLE 4-1 TUBE PIN AND TERMINAL VOLTAGES AND RESISTANCES

Transducer Simulator SM-58/UQS-T1

Component	From	To	V. D. C.	V. A. C.	Ohms	Remarks
	23C-19	23C-17	+2.1	* 22	60	Slewing
	23C-16	23C-17	+3.4		1700	
	23D-7	23D-8		0-90		Brq - 1^X
	23D-7	23D-9		0-90		Brq - 1^X
	23D-8	23D-9		0-90		Brq - 1^X
	23D-10	23D-11		0-90		Brq - 36^X
	23D-10	23D-12		0-90		Brq - 36^X
	23D-11	23D-12		0-90		Brq - 36^X
C-2306	3	1	+340		47,000	
	5	1	+325		46,000	
	7	1	+315		45,000	
C-2307	3	1	+82		139,000	
	5	1	+192		92,000	
V-2301	1	6		680	420	
	7	Grd	+360		48,000	
V-2302	3,4	Grd	+360		48,000	
	5	Grd		* 74	101,000	
	8	Grd	+24.5	* 40	740	
V-2303	1	Grd	+125	* 38	145,000	
	2	Grd		* 1.7	480,000	
	3	Grd	+9.3	* 6.5	5,000	
	6	Grd	+133	* 74	145,000	
	7	Grd		* 40	100,000	
	8	Grd	+6.2	* 18	3,700	
V-2304	1,6	Grd	+82		139,000	
	2	Grd			100,000	No Signal
	3	Grd	+4		3,300	No Signal
	7	Grd			100,000	No Signal
	8	Grd	+4		3,300	No Signal

become disengaged from the sub-structure which mounts the transducer scanner. At this point the scanner rack will be free to move forward on its rollers. Withdraw the sub-structure from the cabinet a distance of approximately 1-1/2 inches and then stop.

(f) Attached to the upper right side wall of the cabinet will be found two one-half inch diameter stainless steel pins, provided with a locating hole at one end only. Each pin is secured between a pair of spring clips rigid to the cabinet wall when not in use. Remove the pins from their mountings.

(g) Attached to the forward vertical angles of the sub-structure will be found a pair of jack screws with knurled knobs, whose axes are vertical to the structure. Below each jack screw will be found a single spring clip rigid to the structure. At each forward and lower corner of the scanner rack a hole has been provided to accommodate the pins. Insert the pins through the holes provided, with their recessed ends pointing upward. Snap each pin in its respective spring clip and note that the end containing the bored hole appears directly under the center of the jack screw. Operate the jack screw downward until it is in mesh with the bored hole in the support pin, and the pin has been driven downward against the friction of the spring clip to the point where it just rests on the base plate of the shock mounted foot assembly, supporting the main structure of the cabinet.

(h) After all preceding steps have been performed the sub-structure may be withdrawn until the mechanical stops have been reached. This operation may best be performed by physically supporting the load by hand, gripping the forward horizontal cross member of the sub-structure at the upper end, and pulling forward until the limit is reached. The support pins referred to above merely act as temporary foot extensions for supporting the sub-structure from the deck. At this point it will be noted that the knurled thumbscrew at the front, midway between the upper and lower sections of the cabinet, can be re-engaged with the sub-structure at its rear support point. This should always be done to provide stability to the assembly when in the opened position.

(i) Remove all power to the equipment and disconnect all 48 input wires from the circular row of terminal posts at the left hand end of the transducer scanner, together with the ground lead attached to the metal cover plate over the bearing. Remove the split bakelite clamp blocks (fastened by two #8 x 32 Allen head cap screws) which support the cable to the sub-structure, and feed the cable back along the inside wall of the cabinet until it is completely divorced from the sub-structure and lies to its rear.

(j) Disconnect the 14 wires connected to both sides of terminal board 23D, visible at the rear to the right of the scanner, Z-2301. Remove the split bakelite clamp blocks which support the cable to the sub-structure, and feed the cable back along the inside wall of the cabinet and free of the sub-structure.

(k) The safety stop plates must next be removed in order to completely withdraw the sub-structure from the cabinet. To the rear of each structural recess used in anchoring the sub-structure will be found a 1/4 inch thick by 1/2 inch wide stainless steel plate held in place by a 1/4 inch x 20 Allen head cap screw. Loosen the screws and rotate stop plates until they no longer block the forward progress of the sub-structure. Next loosen the knurled thumbscrew at the top front of the sub-structure and proceed to complete the withdrawal. Remove the support pins so that the sub-structure may rest squarely on the deck plate.

(l) Remove the eight 3/8 inch x 16 Allen head cap screws securing the scanner to the sub-structure and completely withdraw the transducer scanner.

(2) REPLACEMENT OF 36^X SYNCHRO, B-2301.—Withdraw the transducer scanner sub-structure as described in paragraphs 4*b*(1)*(a)* through 4*b*(1)*(h)*.

(a) The synchro itself is mounted in a cast housing detachable from the end plate of the transducer scanner. Remove the four holding screws which secure this casting to the end plate, and extract the complete assembly, after first disconnecting all wiring to the terminals of the synchro and tagging the leads for reference. Next remove the gear from the synchro shaft by loosening and removing the extended nut and accompanying lockwasher. Dismount the holding clamps which grip the synchro in the cast housing, by removing four screws and lockwashers. Withdraw the synchro from its housing and replace as required.

Assemble in the reverse order of the procedure outlined above. If the gear fails to seat properly over the shaft of a replacement synchro, the flats

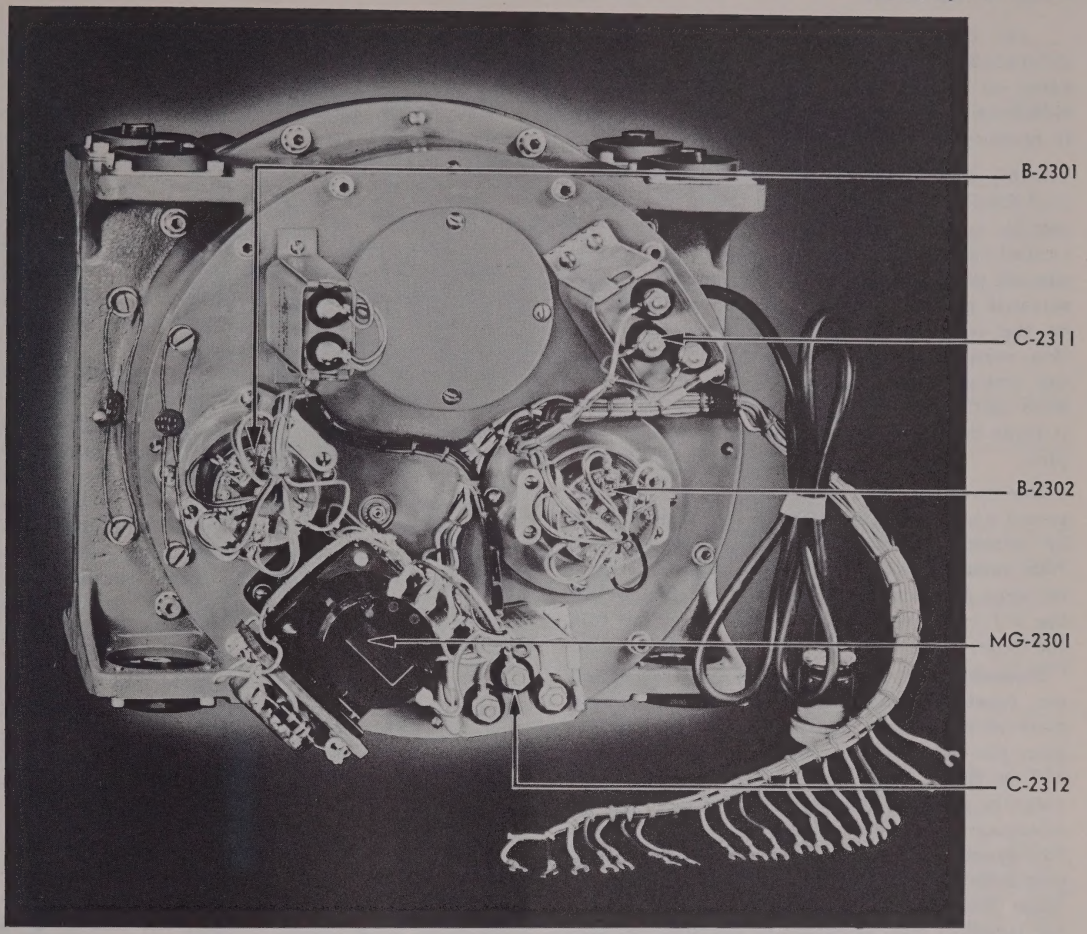


Figure 4-3. Transducer Scanner, Showing End Plate

of the synchro shaft may require deburring. Extreme care should be used to see that only the burr is removed equally on both flat sides of the shaft until a snug fit is obtained.

(b) Zero the synchro as outlined in paragraph 4*c*(1)*(b)*, below.

(3) REPLACEMENT OF 1X SYNCHRO, B-2302.

(a) Proceed as in paragraphs 4*b*(1)*(a)* through 4*b*(1)*(h)*.

(b) Replace synchro as described in paragraph 4*b*(2)*(a)*, above.

(c) Zero the synchro as described in paragraph 4*c*(1)*(a)*, below.

(4) REPLACEMENT OF MOTOR GENERATOR UNIT, MG-2301.

(a) Proceed as in paragraphs 4*b*(1)*(a)* through 4*b*(1)*(h)*.

(b) Remove the leads to the terminals of MG-2301, then remove the component board and small terminal strip from the sides of the unit, allowing them to hang by their leads.

(c) Remove four screws near the motor generator base plate and carefully withdraw the unit.

(d) Replace the new unit and assemble in the reverse order. No zeroing is required for MG-2301.

(5) SIGNAL AND SERVO AMPLIFIER CHASSIS.—Replacement procedures for components on this chassis are self evident, however, reference to the component locations, figure 4-4, is recommended.

(6) REPLACEMENT OF TRANSDUCER SCANNER, Z-2301.—After the entire scanner assembly sub-structure has been removed as described in paragraphs 4*b*(1)*(a)* through 4*b*(1)*(l)*, the end plate which contains the synchros and associated gearing must be removed and installed on the replacement transducer scanner. To do this, remove the twelve 1/4 inch x 20 Allen head cap screws used to secure the end plate to the main casting, and remove the end plate by prying it loose in the region of the four locating dowel pins.

Dismount the train plate holding the two compound gear staffs captive to the end bell casting by removing four #10 x 32 round head screws. Next remove the locknut and lockwasher securing the spur gear to the scanner rotor shaft and with the aid of a gear puller, extract the gear from the shaft, being careful not to loose the shaft key.

Assemble the spur gear, lockwasher, locknut, etc., together with the compound gears and train plate, on the replacement transducer scanner. Replace the end plate complete with the servo motor and synchro complement. In the event of difficulty in meshing the gears properly, it may be advantageous to remove the access plate above the two synchros, thus providing an access hole for manipulating the gear staffs for proper seating. After the end plate has been secured in place, the synchros may be zeroed as described in paragraps 4*c*(1)*(a)* and 4*c*(1)*(b)*. Transpose the P-2303 identification tag to the connector attached to the new assembly.

c. EQUIPMENT ADJUSTMENT.

(1) SYNCHRO ZEROING.—If this operation is to be performed without completely extracting the transducer scanner from the mounting rack, but the rack has been withdrawn as in paragraph 4*b*(1)*(a)* through 4*b*(1)*(h)*, it is recommended that all connecting wires to the right hand side of the 23D terminal board be removed to prevent false registrations and/or possible short circuits. In any event, dependent upon the conditions which may prevail at the time, any reference hereinafter made to the required test facilities and points of electrical circuit check will include the synchro terminal meanings, together with their 23D terminal board terminations. Choice of either test point will be dictated by either by the circumstances or conveniences to be gained.

Remove the lucite cover plate from the transducer scanner lower front face, and rotate the rotor plate by hand until the orange painted index is brought into agreement with the index on the stator plate (see figure 3-2).

(a) 1 HCT CONTROL TRANSFORMER, B-2302.—Connect one side of a 75 volt A.C. 60 cycle source to terminals S-1 (23D-7), S-3(23D-9), R-2(no 23D- termination), and the other side to terminal S-2(23D-8) of 1^X control transformer B-2302. Connect a variable range A. C. voltmeter between terminals R-1 (23D-1) and R-2 (no 23D- termination), and note that this voltage is zero as measured on the low range scale of the voltmeter. If not, loosen the two clamp plates which lock the synchro to its cast housing, and rotate the body of the synchro until the measured voltage becomes precisely zero. To ascertain that correct zero has been obtained, rearrange the voltmeter connections (high range scale) to measure the voltage between R-1 (23D-1) and S-2 (23D-8). Next rotate the synchro body in a clockwise direction and note that the measured voltage increases. If it does not, the correct zero will be found by rotating the body of the synchro 180 degrees to a new voltage zero. After locating the proper zero, carefully lock the synchro in place by tightening the clamping plates.

(b) 1 HCT CONTROL TRANSFORMER, B-2301.—With the lucite cover plate removed and the rotor and stator indexes in agreement as in *(a)*, above, connect one side of a 75 volt A.C. 60 cycle source to terminals S-1 (23D-10), S-3 (23D-12), R-2 (23D-4), and the other side to terminal S-2 (23D-11) of 36^X control transformer B-2301. Connect a variable range A.C. voltmeter between R-1 (23D-5) and R-2 (23D-4), and note that this voltage is zero as measured on the low range scale of the voltmeter. If it is not, loosen the two clamp plates which lock the synchro to its cast housing, and rotate the body of the synchro until measured voltage becomes precisely zero. To ascertain that correct zero has been obtained, rearrange the voltmeter connections (high range scale) to measure the voltage between R-1 (23D-5) and S-2 (23D-11). Next rotate the synchro body in a clockwise direction and note that the measured voltage increases. If it does not, the correct zero will be found by rotating the body of the synchro 180 degrees to a new voltage zero. After locating the proper zero, carefully lock the

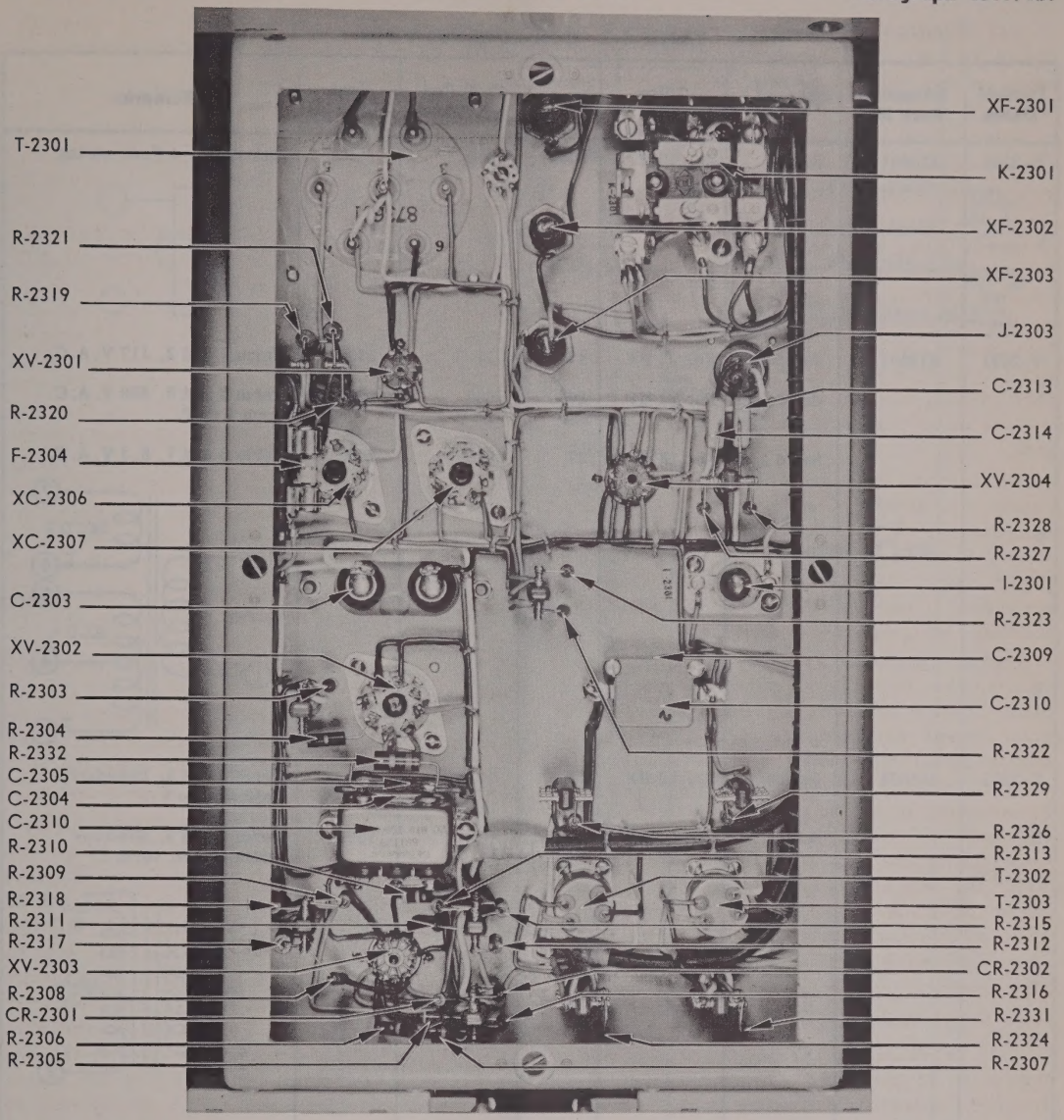


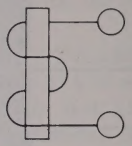
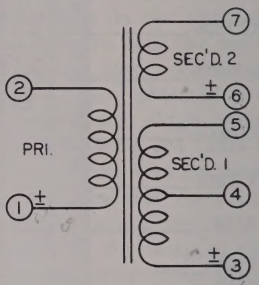
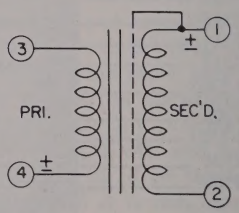
Figure 4-4. Component Location, Amplifier Chassis

synchro in place by tightening the clamping plates.

d. LUBRICATION.

All bearing surfaces in Transducer Simulator SM-58/UQS-T1 have been lubricated for life at the time of manufacture, and no further lubrication is desirable.

TABLE 4-2 COIL WINDING DATA

Symbol Desig.	Sangamo Part No.	Winding	Wire Size	Turns	D. C. Res. In Ohms	Test Voltage	Remarks
K-2301	870061	Single	No. 35 E	5200	400	--	Relay coil, 4 V. A. rating 
T-2301	873601	Primary	No. 27 HF	476	11	2300	Term 1 and 2, 117 V. A. C.
		Sec'd 1	No. 34 HF	2940	420	2300	Term 3 and 5, 680 V. A. C., term 4 C. T.
		Sec'd 2	No. 18 HF	27	0.09	2300	Term 6 and 7, 6.3 V. A. C. 
T-2302	873609	Primary	No. 32 HF	58	1.04	500	Term 3 and 4, Impedance Ratio 5.7 to 1
		Sec'd	No. 30 HF	138	2.31	1500	Term 1 and 2, Electro-static shield, term 1 

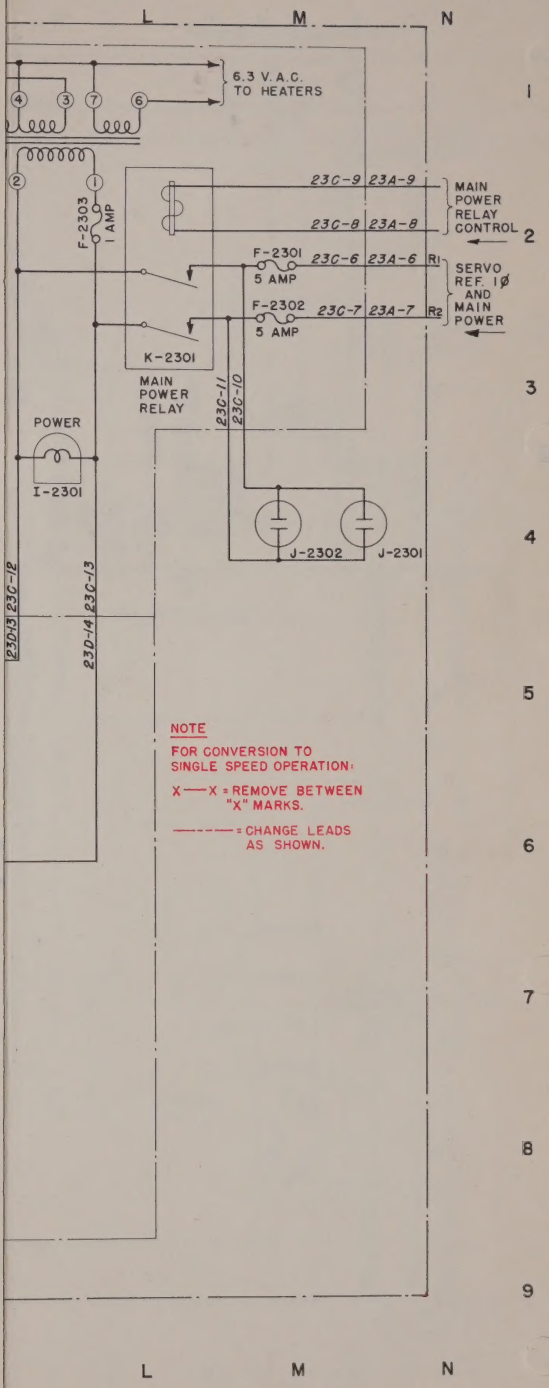
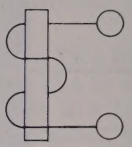
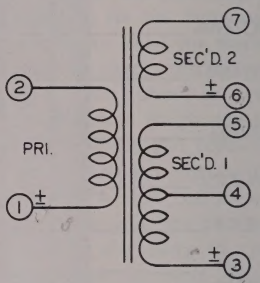
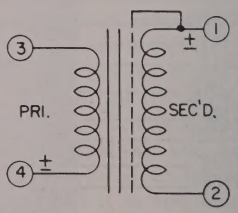


Figure 4-5. Transducer Simulator, Schematic

TABLE 4-2 COIL WINDING DATA

Symbol Desig.	Sangamo Part No.	Winding	Wire Size	Turns	D. C. Res. In Ohms	Test Voltage	Remarks
K-2301	870061	Single	No. 35 E	5200	400	--	Relay coil, 4 V. A. rating 
T-2301	873601	Primary	No. 27 HF	476	11	2300	Term 1 and 2, 117 V. A. C.
		Sec'd 1	No. 34 HF	2940	420	2300	Term 3 and 5, 680 V. A. C., term 4 C. T.
		Sec'd 2	No. 18 HF	27	0.09	2300	Term 6 and 7, 6.3 V. A. C. 
T-2302	873609	Primary	No. 32 HF	58	1.04	500	Term 3 and 4, Impedance Ratio 5.7 to 1
		Sec'd	No. 30 HF	138	2.31	1500	Term 1 and 2, Electro-static shield, term 1 

B-2301	H7	F-2303	L2	R-2317	F3
B-2302	F7	F-2304	J3	R-2318	F3
C-2301	J5	I-2301	K3	R-2319	I1
C-2302	J6	J-2301	N4	R-2320	I1
C-2303	I4	J-2302	M4	R-2321	I2
C-2304	H2	K-2301	L3	R-2322	F1
C-2305	H2	MG-2301	J7	R-2323	F1
C-2306	H2	R-2301	I5	R-2324	A3
C-2306	I2	R-2302	I6	R-2326	B4
C-2306	J2	R-2303	H4	R-2327	C4
C-2307	F2	R-2304	I3	R-2328	D4
C-2307	F2	R-2305	H4	R-2329	D4
C-2308	B3	R-2306	G4	R-2331	E3
C-2309	D3	R-2307	H4	R-2332	I3
C-2310	I3	R-2308	H2	T-2301	K1
C-2311	E8	R-2309	G2	T-2302	B4
C-2312	I8	R-2310	G3	T-2303	E4
C-2313	C4	R-2311	G3	V-2301	K3
C-2314	C4	R-2312	G3	V-2302	J3
CR-2301	F4	R-2313	F4	V-2303	G3
CR-2302	F4	R-2314	F6	V-2304	C3
F-2301	M2	R-2315	G4	Z-2301	C7
F-2302	M3	R-2316	E4		

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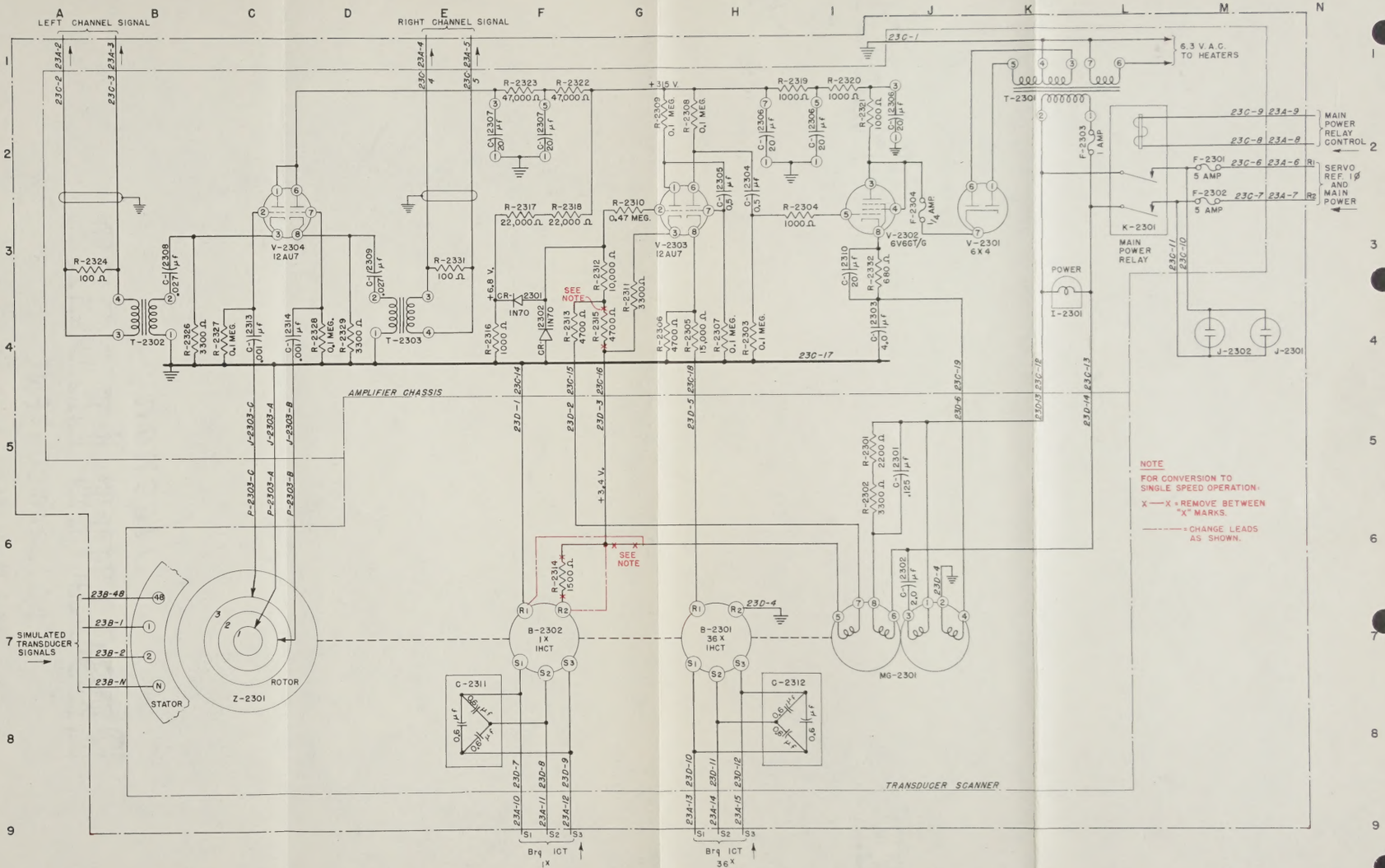

Figure 4-5. Transducer Simulator, Schematic

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Test Voltage	Remarks
	Relay coil, 4 T.A.C. relays
2500	Terms 1 and 2, 115 V. A.C.
2500	Terms 1 and 2, 460 V. A.C., Note A.C. 2
2500	Terms 3 and 4, 2.3 V. A.C.
500	Terms 1 and 2, Impedance Coil 3 Term 1
2500	Terms 1 and 2, Impedance Coil 3 Term 1

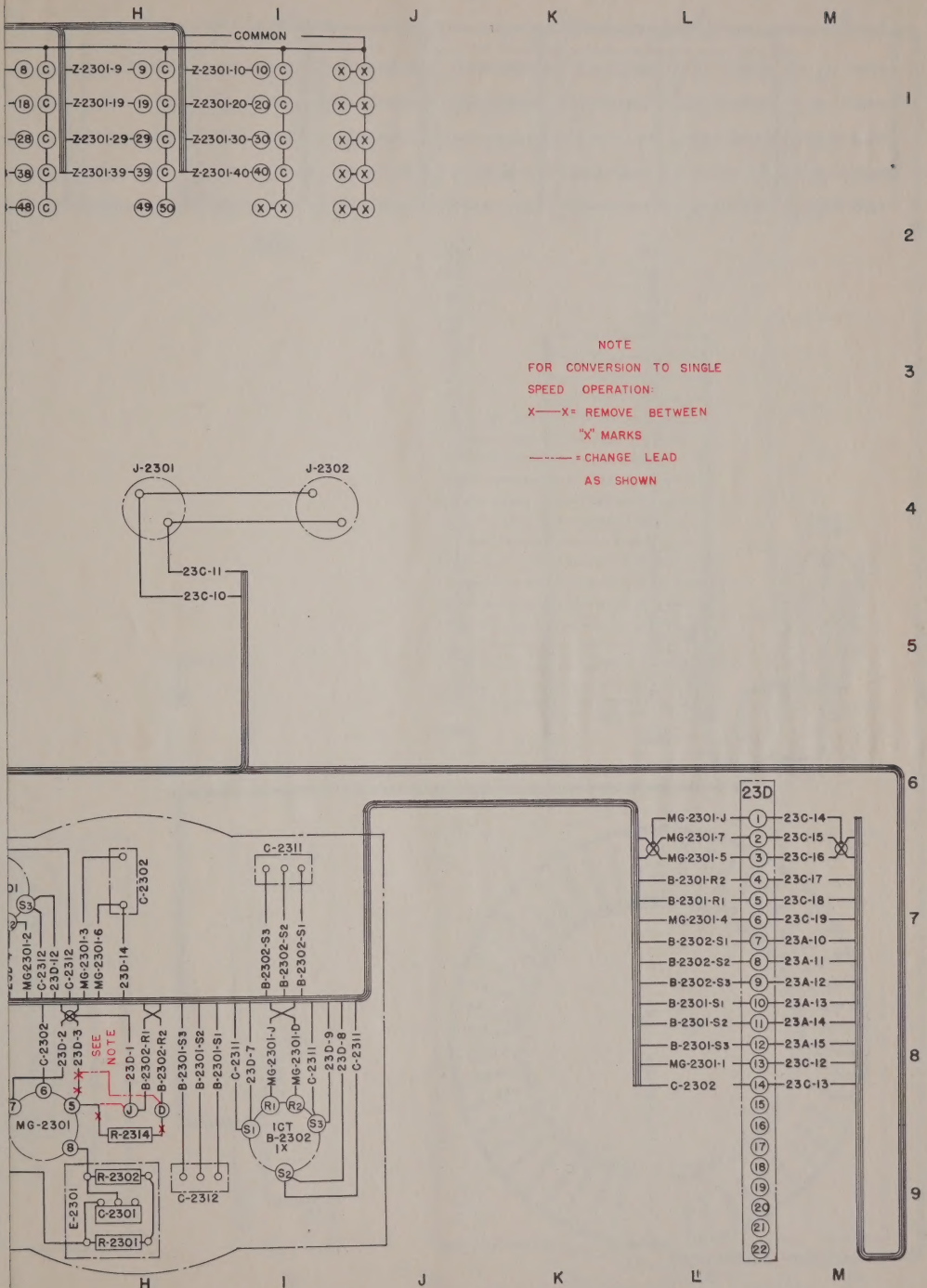

Figure 4-6. Cabinet Wiring, Transducer Simulator

	Test Voltage	Remarks
		Relay coil, A.C. or D.C.
	230V	Terminal 1 and 2, 115 V. A.C.
	230V	Terminal 1 and 2, 230 V. A.C., 60 cycle, A.C.
	230V	Terminal 1 and 2, 6.3 V. A.C.
	50V	Terminal 1 and 2, Impedance 2000 ohms
	230V	Terminal 1 and 2, Resistor, 4000 ohms, 10 watt

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B-2301	G7	MG-2301	G8
B-2302	I9	P-2303	A4
C-2301	H9	R-2301	H9
C-2302	H7	R-2302	H9
C-2311	I7	R-2314	H9
C-2312	H9	Z-2301	E9
E-2301	H9	23A	D6
J-2301	H4	23B	E2
J-2302	I4	23C	B6
J-2303	A4	23D	L6

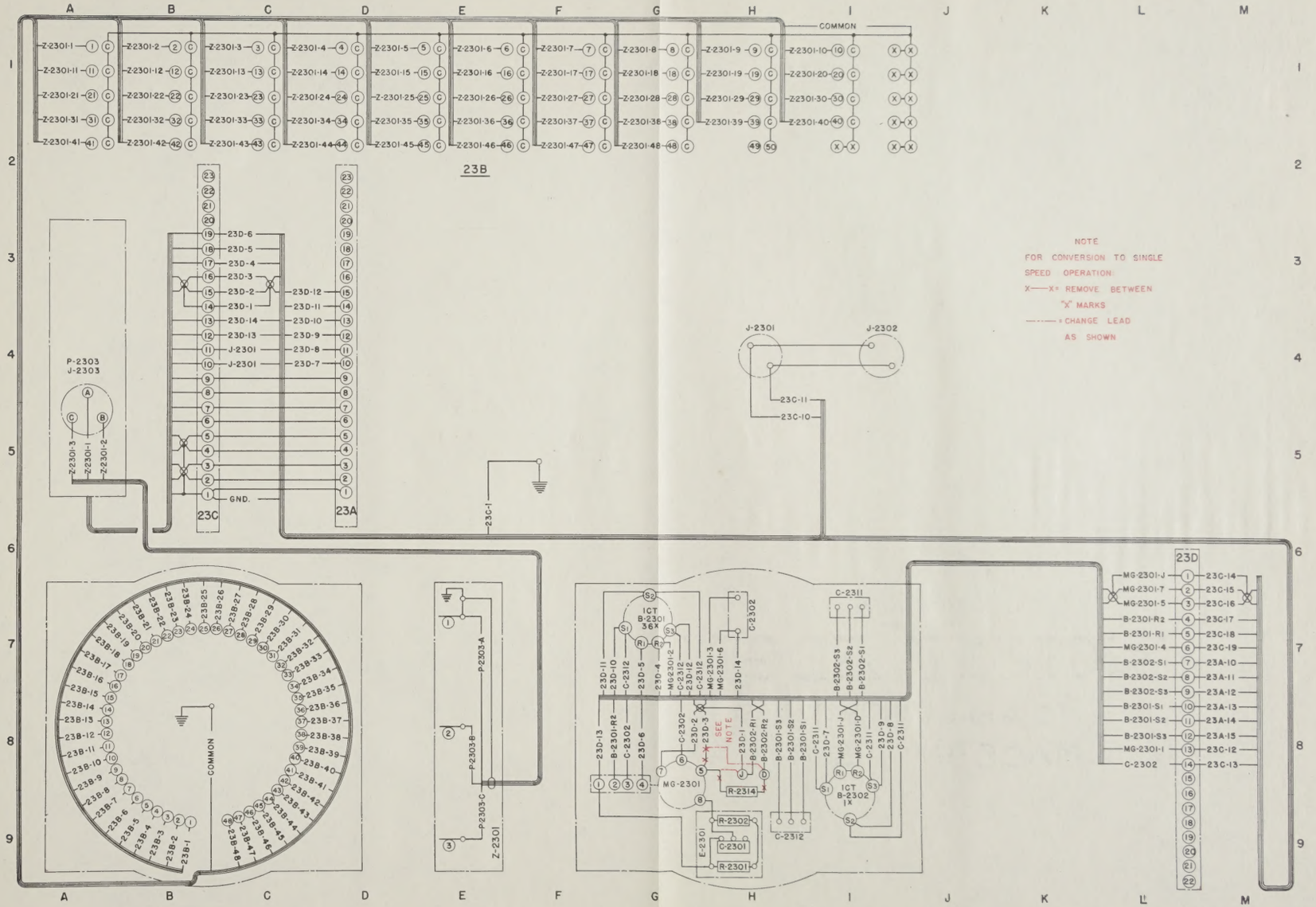

Figure 4-6. Cabinet Wiring, Transducer Simulator

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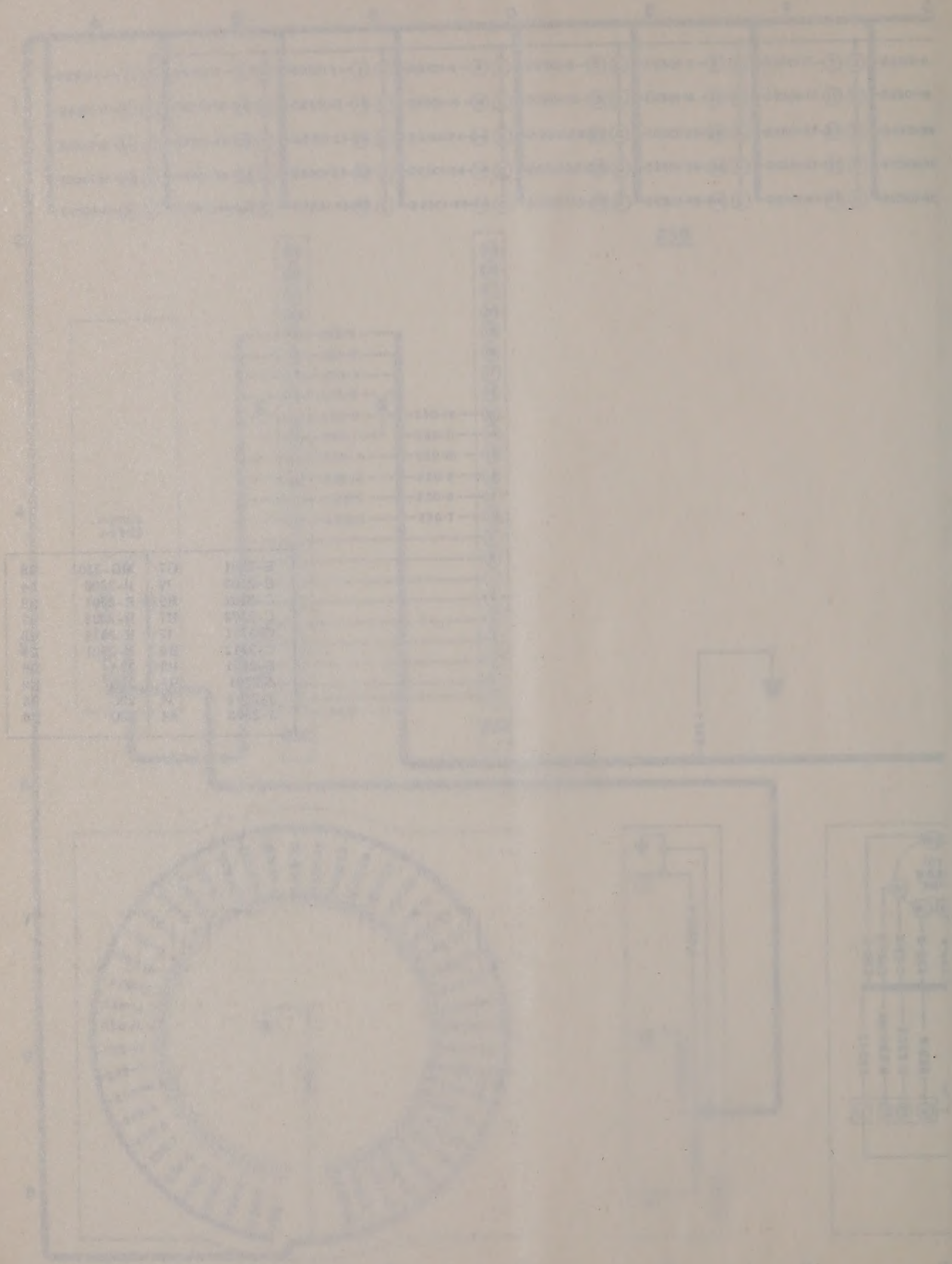


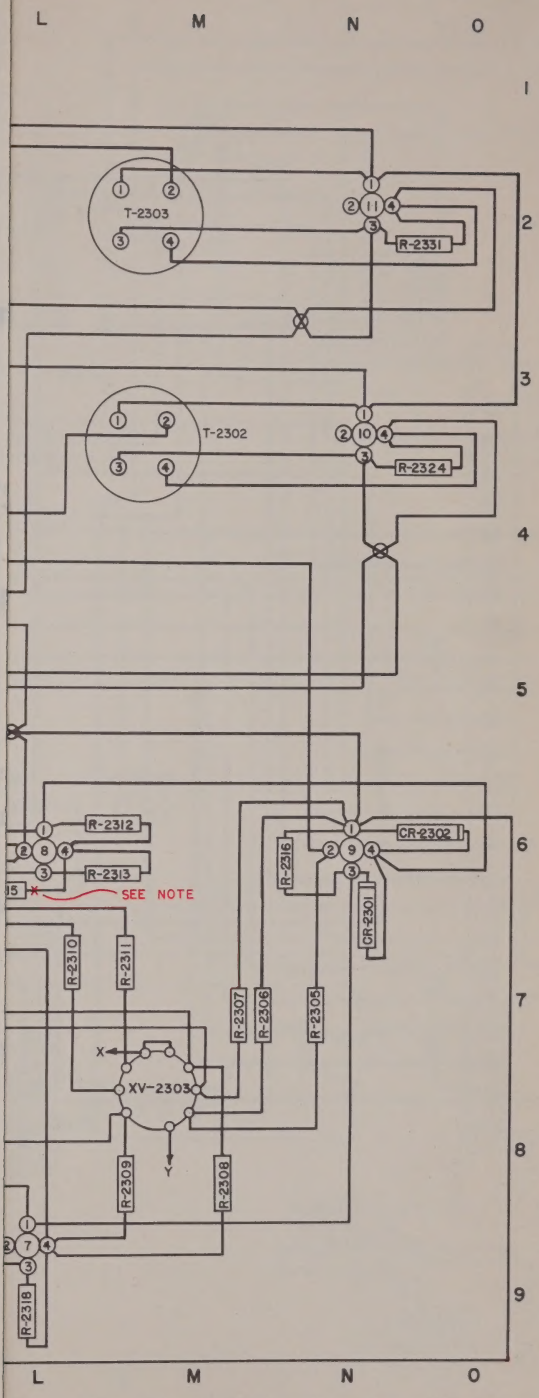
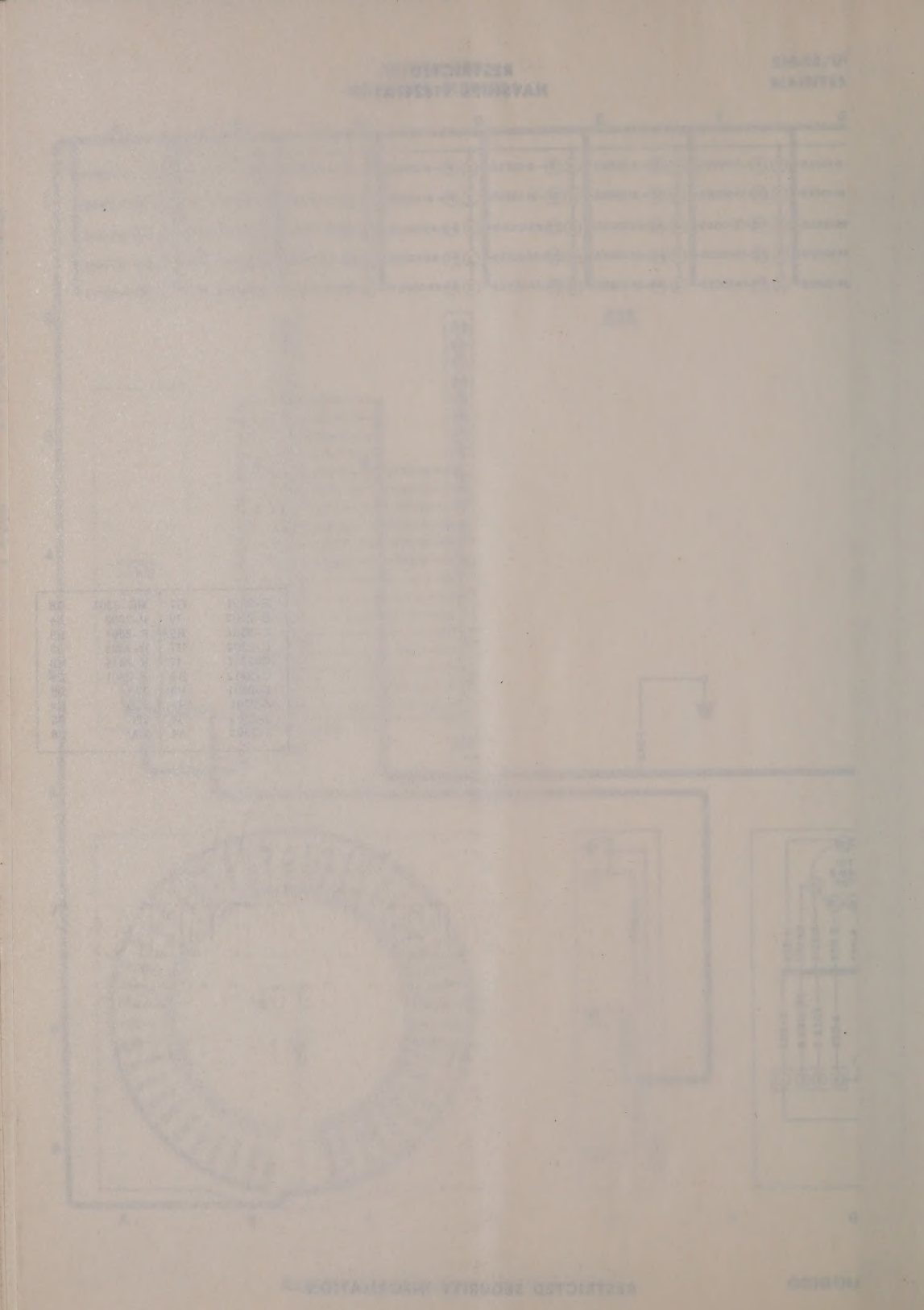


Figure 4-7. Chassis Wiring, Transducer Simulator



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C-2303	I8	K-2301	D3	R-2326	J4
C-2304	K8	R-2303	K9	R-2327	F3
C-2305	K8	R-2304	J8	R-2328	G3
C-2308	I3	R-2305	N7	R-2329	J2
C-2309	J3	R-2306	M7	R-2331	O2
C-2310	K8	R-2307	M7	R-2332	J8
C-2313	F2	R-2308	M8	T-2301	D8
C-2314	G3	R-2309	M8	T-2302	M3
CR-2301	N6	R-2310	L7	T-2303	M2
CR-2302	O6	R-2311	M7	XC-2306	H8
J-2303	F1	R-2312	L6	XC-2307	H7
JP1	G9	R-2313	L6	XF-2301	C6
JP2	F3	R-2315	L6	XF-2302	D6
JP3	I6	R-2316	N6	XF-2303	E6
JP4	J9	R-2317	L8	XF-2304	I9
JP5	K3	R-2318	L9	XI-2301	H1
JP6	K2	R-2319	F8	XV-2301	F7
JP7	L9	R-2320	F8	XV-2302	J8
JP8	L6	R-2321	G9	XV-2303	M8
JP9	N6	R-2322	I6	XV-2304	H3
JP10	N3	R-2323	I6	23C	A8
JP11	N2	R-2324	O3		

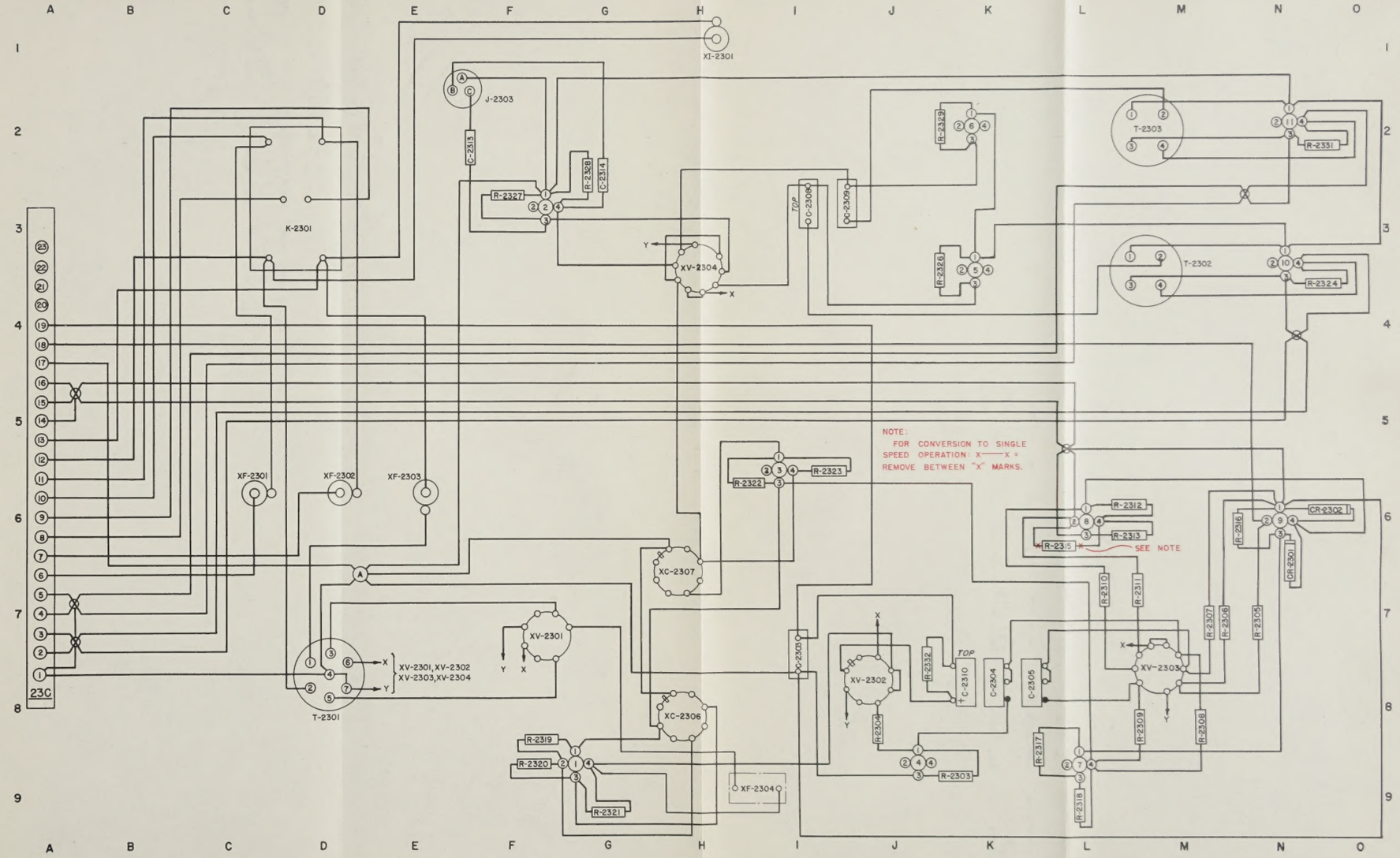

Figure 4-7. Chassis Wiring, Transducer Simulator

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SECTION 5

PARTS LISTS

LIST OF TABLES

TABLE	TITLE	PAGE
Table 5-1	Weights and Dimensions of Spare Parts Boxes	5-2
Table 5-2	Shipping Weights and Dimensions of Spare Parts Boxes	5-2
Table 5-3	List of Major Units	5-2
Table 5-4	Table of Replaceable Parts	5-3
Table 5-5	Maintenance Parts Kit	5-10
Table 5-6	Cross Reference Parts List	5-11
Table 5-7	Color Codes and Miscellaneous Data	5-12
Table 5-8	List of Manufacturers	5-13

TABLE 5-1. WEIGHTS AND DIMENSIONS OF SPARE PARTS BOXES

Spare Parts Box	Overall Dimensions (Inches)			Volume (Cu. Ft.)	Weight (Lbs.)
	Height	Width	Depth		
A	6	13	18	0.81	24

TABLE 5-2. SHIPPING WEIGHTS AND DIMENSIONS OF SPARE PARTS BOXES

Shipping Box	Spare Parts Box	Overall Dimensions (Inches)			Volume (Cu. Ft.)	Weight (Lbs.)
		Height	Width	Depth		
1	A	48	27	32	24	437

TABLE 5-3. LIST OF MAJOR UNITS

Symbol Group	Name of Unit	Navy Type Designation	Standard Navy Stock Number	Quantity
2301-2399	Transducer Simulator	SM-58/UQS-T1		1

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
A-2301 thru A-2304	- N17-M-75387-1823 -	MOUNT, vibration: square mtg base, round cover; 60-168 lbs, 0.013 to 0.032 inches deflection; approx 3'' lg x 3'' wd x 1-1/2'' h o/a; 2 rubber cushions, 2-7/8'' diam x 15/16'' h and 2'' diam x 11/16'' h; steel center sleeve with 3/8'' diam hole; steel; four 0.266'' diam mtg holes 2-1/2'' c to c; corrosion resistant; mfd by L. N. Barry Co. type #C-2070-6; Sangamo part #876209	Supports cabinet
A-2305	- N17-M-75247-3501 -	MOUNT, vibration: sq holder mtg; 60 lb load rating; 3'' lg x 3'' wd x 2-5/16'' h o/a; rubber cushion 2'' diam x 1-13/16'' thk; steel ctr sleeve w/0.391'' bolt hole; brass holder; 4 mtg holes 0.257'' diam on 2-1/2'' ctrs; holder cad plated; mfd by Lord Mfg. Co. part #200XPH60; Sangamo part #881136	Rear cabinet support
A-2306		Same as A-2305	Rear cabinet support
A-2307	If required will be procured by nearest Navy Shore Supply Activity on demand	GROMMET, rubber: fits 1-3/16'' diam hole; 7/8'' hole diameter x 9/64'' wd groove x 15/32'' wd x 1-3/8 diam o/a; mfd by Atlantic India Rubber Co., cat. #1626-A; Sangamo part #871013	Cable entry
A-2308	If required will be procured by nearest Navy Shore Supply Activity on demand	GROMMET, rubber: fits 3/4'' hole; 19/32'' hole diam, groove width 7/64'', 19/64'' o/a width x 15/16'' o/a diam; mfd by Atlantic India Rubber Co., part #1177; Sangamo part #873921	Cable entry
A-2309		Same as A-2307	Cable entry
B-2301	- Z17-M-61237-4201 -	MOTOR, self synchronous: Navy synchro type 1HCT Mk 11 Mod 3, 3A, 4 & 4A; 90/55 v, 60 cyc, single ph; 2-1/4'' diam x 4-1/8'' lg o/a; closed frame; shaft extension 0.2'' diam x 1/2'' lg; threaded end with keyed washer attachment; mtg fl 2-1/4'' OD, 2'' ID, 1/4'' thk; 5 screw term on end block; mfd by BuOrd dwg #950504; Sangamo part #870085	36 speed 1 HCT
B-2302		Same as B-2301	1 speed 1 HCT
C-2301	- N16-C-53433-4108 -	CAPACITOR, fixed: Navy type -483496-15; paper dielectric; 2 sect; 250,000 mmf ±15% per sect; 600 vdcw; HS steel case; 1-13/16'' lg x 1-1/4'' wd x 3/4'' h less term and mtg ears; mineral oil impr and filled; 3 solder lug term on front; LH term common; no int gnd connection; 2 mtg ears with holes 5/32'' diam, spaced 2-1/8'' c to c; mfd by Sangamo part #817552	Phasing, MG-2301
C-2302	- N16-C-49197-3160 -	CAPACITOR, fixed: paper dielectric; JAN type CP70B1EF-205K; 2 mf ±10%; 600 vdcw; no int gnd; mfd by Sangamo part #881039	Phasing, MG-2301
C-2303	For replacement use N16-C-49957-5970	CAPACITOR, fixed: paper dielectric JAN type CP70B1FF-405K; 4.0 mf ±10%; 600 v; oil filled; no int gnd; mfd by Sangamo part #873972 (CP70B1CF405K)	Variable phase, MG-2301
C-2304		Same as C-2301	Coupling, pin 6, V-2303
C-2305		Same as C-2301	Coupling, pin 1, V-2303
C-2306	- N16-C-22641-4762 -	CAPACITOR, fixed: electrolytic; JAN type CE53A200Q; 3 sect; 20-20-20 mfd; 400 vdcw per sect; mfd by Sangamo part #881230	Filter, positive power supply
C-2307		Same as C-2306	Filter, positive power supply
C-2308	For replacement use N16-C-34672-8576	CAPACITOR, fixed: mica dielectric; JAN type CM50B273K; 27,000 mmf ±10%; 600 v; temp coeff ltr B; mfd by Sangamo part #873129 (CM50B273J)	Coupling, pin 3, V-2304
C-2309		Same as C-2308	Coupling, pin 8, V-2304

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
C-2310	- N16-C-19713-8741	CAPACITOR, fixed: electrolytic; JAN type CE63A200J; 20 mf; 150 vdcw; mfd by Sangamo part #881129	Cathode bypass, V-2302
C-2311	- Z16-C-54623-4782 -	CAPACITOR, fixed: Navy type Mk 12 Mod 2, type 1C; paper dielectric; three sect; delta connected; ea sect 0.6 mfd ±10% except that ea sect must be ±1% of mean of the three sect; 90 v, 60 cycles; HS metal case; 3.125" h x 2.437" wd x 1.687" dp less terms; oil filled; three screw term on top; delta connected; 2 removable L brackets, with 2 mtg slots .213" x 9/32" on .625" center each; mfd by Navy Dept., BuOrd #257136; Sangamo part #878030	Power factor correction, B-2302
C-2312		Same as C-2311	Power factor correction, B-2301
C-2313	- N16-C-31090-4164	CAPACITOR, fixed: mica; JAN type CM30B102K. 1000 mmf ±10%; 500 v; coeff ltr B; mfd by Sangamo part #803772	Coupling, pin 2, V-2304
C-2314		Same as C-2313	Coupling, pin 7, V-2304
CR-2301	- N16-T-51770 -	RECTIFIER, crystal: JAN-1N70; rectifier; inverse voltage 125 v peak, peak anode current 90 ma, average anode current 30 ma, forward current at +1 v 3 ma, reverse current at -50 v 0.41 ma max; 0.25" dia x 1/2" lg exc leads; two 1" lg wire leads; narrow band marks cathode terminal; mfd by General Electric Co., type 1N70; Sangamo part #878134	Servo amplifier limiter, pin 2, V-2303
CR-2302		Same as CR-2301	Servo amplifier limiter, pin 2, V-2303
E-2301	- N17-B-88240-7175 -	BRUSH ASSEMBLY, electrical contact: 1 Sangamo #871195 Brush Holder Bushing 1 #871044 Brush Holder Stud, 1 #871113 Backing Blade (med) 1 #871114 Backing Blade (long) 1 #871517 Brush Holder Arm, 1 #871518 Spring Blade, 1 #871519 Brush Holder, 1 #871521 Spacer; brushes grade 411 silver graphaloy, silver pl, Sangamo 871070; two cont pieces on leaf spring holder, holder mtd on hex support post 3.08" w x 3-5/8" lg x 1.98" h o/a; three 0.13" diam mtg holes spaced 120° on 1.687" diam mtg circle; bakelite holder marked "1"; mfd by Sangamo part #871524	Scanner contact
E-2302	- N17-B-88238-2146 -	BRUSH ASSEMBLY, electrical contact: Sangamo #871196 Brush Holder bushing, 1 #871043 Brush Holder Stud, 1 #871113 Backing Blade (med) 1 #871114 Backing Blade (long), 1 #871517 Brush Holder arm, 1 #871518 spring blade, 1 #871519 Brush Holder, 1 #871521 spacer; 2 brushes grade 411 silver graphaloy, silver pl (Sangamo #871070); two cont pieces on leaf spring holder, holder mtd on hex support post 2.68" lg held in round bakelite base; 2.68" w x 3-5/8" lg x 1.98" h o/a; three 0.13" diam mtg holes spaced 120° on 1.687" diam mtg circle; bakelite holder marked "2"; mfd by Sangamo part #871523	Scanner contact
E-2303	- N17-B-88234-7201 -	BRUSH ASSEMBLY, electrical contact: c/o Brush Holder bushing Sangamo part/dwg #871197, Brush Holder stud Sangamo part/dwg #871042, Backing Blade (med) Sangamo part/dwg #871113, Backing Blade (long) Sangamo part/dwg #871114, Brush and Holder Assembly Sangamo part/dwg #871520; 2 brushes grade 411 silver graphaloy, silver pl; two cont pieces on leaf spring holder, holder mtd on hex support post 2.325" lg held in round bakelite base; approx 3-5/8" lg x 2" wd x 2.325" h o/a; three 0.13" diam mtg holes spaced 120° on 1.687" diam center line; bakelite holder marked "3"; mfd by Sangamo part #871552	Scanner contact

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
F-2301	- N17-F-14305-1165 -	FUSE, cartridge: Navy type -28035-5; 5 amp, opens in 60 min at 135% load, carries continuously 110% load; 250 v; one time; glass body; ferrule term; 9/32" diam x 1-1/4" lg; mfd by Bussman Mfg. Co. part #AGS-5; Sangamo part #870624	Protects singlephase input
F-2302		Same as F-2301	Protects singlephase input
F-2303	- N17-F-14309-330 -	FUSE, cartridge: Navy type -28035-1; 1 amp, opens in 60 min at 135% load, carries continuously 110% load; 250 v; one time; glass body; ferrule term; 9/32" diam x 1-1/4" lg; mfd by Bussman Mfg. Co. part #AGS-1; Sangamo part #870168	Protects primary of T-2301
F-2304	- N17-F-14309-310 -	FUSE, cartridge: 1/4 amp, opens in 60 min at 135% load, carries continuously 110% load; 250 v, one time; glass body; ferrule term; 9/32" diam x 1-1/4" lg; mfd by Bussman Mfg. Co. part #AGS-1/4; Sangamo part #874563	Protects D.C. high voltage line
H-2301	For replacement use N16-S-34607-6039	SHIELD, electron tube: cad plate steel; round, ventilating holes; bayonet mtd; 2-1/4" lg o/a x 0.810" ID x 7/8" OD; with internal spring, 5/8" lg and 1/2" top hole; for 7 pin miniature tube; mfd by Cinch Mfg. Corp. per Sangamo #890385; Sangamo part #890385	Holds V-2301
H-2302	- N16-C-300487-126 -	CLAMP, electron tube; type 302 SS; one mtg screw employed; 1-7/8" lg x 1-1/2" wd x 3/4" h o/a; clamps intermediate shell octal base tubes; mfd by Birtcher Corp. part #926-B2; Sangamo part #870056	Holds V-2302
H-2303	For replacement use N16-S-34576-6414	SHIELD, tube: aluminum body; round, open top; bayonet mtg; 1-15/16" lg x 15/16" diam I.D.; coil spring approx 7/8" from top; mfd by Cinch Mfg. Co. part #952; Sangamo part #892011	Holds V-2303
H-2304		Same as H-2303	Holds V-2304
H-2305		Not used	
H-2306	- N16-C-300798-886 -	CLAMP: plug-in electrolytic capacitor; type 302SS; one mtg screw employed; 1-3/8" ID x 3/4" h excl loop; clamps pos octal base capacitor, 1-3/8" OD; mtg bkt w/3/16" x 5/16" lg slot on 29/32" rad has no holding spur; mfd by Birtcher Corp. part #926-C-30; Sangamo part #881248	Holds C-2306
H-2307		Same as H-2306	Holds C-2307
H-2308	For replacement use G41-W-2455	WRENCH: Allen; 5/16" across flats; 4-3/16" lg x 1-1/16" wd x 7/16" thk o/a; alloy steel; 90 degree offset; hex straight handle; for 3/8" Allen setscrew; mfd by Allen Mfg. Co.; Sangamo part #876288	Scanner repair
I-2301	For replacement use N17-L-3916-205	LAMP, incandescent: 155 v, 6 w; bulb S-6 clear; 1-3/4" lg o/a; candelabra base; S-7A fil; burn any position; mfd by General Electric Co. type #6S6; Sangamo part #812153	"POWER" indicator
J-2301	For replacement use N17-C-73125-2568	CONNECTOR, receptacle: two female non-polarized rectangular contacts; straight type; 2-3/16" lg x 1-3/8" wd x 9/16" h less cont; cylindrical bakelite body; two oblong mtg holes 5/16" lg x 0.14" wd on 1-11/16" mtg/c; mfd by American Phenolic Corp. cat. #73 - #61-F1; Sangamo part #891036	Convenience outlet
J-2302		Same as J-2301	Convenience outlet
J-2303	- N17-C-72604-4794 -	CONNECTOR, receptacle: three round cont; straight type; 1-9/32" wd x 1-9/32" h 29/32" d, less solder term; 10 amp, 200 v; cylindrical aluminum body, anodized; molded melamine insert, tropicalized; 4 mtg holes 0.12" diam on 31/32" mtg/c threaded end 1" diam x #20 thd; AN-3102-16S-5PH; mfd by American Phenolic Corp. part #AN-3102-16S-5PH; Sangamo part #873941	Signal input connector

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
K-2301	- N17-R-64130-5465 -	RELAY, armature: Navy type -29846; DPST normally open; cont rating 15 amp, 110 v; silver cont 5/16" diam; single winding, 117 v 60 cyc AC, cur rating 4 va, DC resistance 400 ohms, ins coil; screw term on coil and cont; 2-1/2" lg x 2-9/16" wd x 2-1/4" h o/a; two 3/16" mtg holes on 1-7/8" mtg/c; fast acting; impr for tropical use; mfd by Potter Brumfield Mfg. Co. part #PR1146; Sangamo part #870061	Singlephase power control
MG-2301	- F17-M-69418-9219 -	MOTOR GENERATOR UNIT: servo positioning unit, gen used for damping; gen output 6.5 v ±10%, 60 cyc, singlephase at 1000 rpm, gen excitation 82 v, 60 cyc, singlephase, max residual 120 mv, max variation 80 mv; motor input phase 1 - terminals 1 & 3, 115 v, 154 ma, phase 2 - terminals 2 & 4, 72 v, 246 ma, total watts 6.5, 60 cyc; motor stalled torque 7.1 inch oz; max temp rise 37 degrees C; four 0.196" diam mtg holes on 1.876" x 1.876" mtg/c, in mtg fl on end of motor; 6-3/4" lg x 2-1/2" wd x 2-29/32" h o/a; squirrel cage motor, 2 pole, ind cup gen, 2 pole, one winding excited, other winding gives output v proportional to speed of rotation; mfd by Sangamo part #890388	Drives scanner
N-2301	- N17-L-250763-401 -	LENS, indicator light: red; single lens type; 1-3/4" diam x 1/32" thk red plasticele disk lens, three 0.147" diam mtg holes spaced 120° on 1.4" circle; no bezel; mfd by Sangamo part #882341	Filter for "POWER" lens
N-2302	- N17-L-250884-551 -	LENS, indicator light: white frosted letters on black background, "POWER"; slotted push-on type; 1" diam clear lucite disk lens; bezel 1-1/8" diam x 1/2" h o/a; brass, chrome finish bezel; mfd by Sangamo part #881200	"POWER" indicator lens
O-2301	- N17-G-433596-311 -	GEAR: spur type; Meehanite metal; straight teeth; 135 teeth; 48 pitch; 2.8125" PD, 2.858" OD, 0.6693" bore, 1" thk o/a; concave face; hub extends 0.563" beyond face of gear, diam 1.383"; keyway in gear 1/8" wd x 1/16" d; mfd by Sangamo part #871805	On rotor shaft of scanner
O-2302	- N17-G-433596-281 -	GEAR: spur; brass; straight teeth; 135 teeth; 48 pitch; 2.8125" PD, 2.858" OD x 0.555" lg o/a; straight face; hub one side 0.45" diam x 0.187" lg; hub csk 0.2035" diam x 0.28" d, oblong hole at end of countersink 0.195" lg x 0.1255" wd; mfd by Sangamo part #871789	On shaft of B-2302
O-2303	- N17-G-414999-191 -	GEAR: spur; brass; helical teeth; helix angle 28° 57' RH; 105 teeth; 64 pitch; 1.875" PD, 1.933" OD x 0.555" lg o/a; straight face; hub one side 0.45" diam x 0.187" lg; hub csk 0.2035" diam x 0.28" d, oblong hole at end of countersink 0.195" lg x 0.1255" wd; mfd by Sangamo part #871802	On shaft of B-2301
O-2304	- N16-G-500001-102 -	GEAR ASSEMBLY: compound shaft; brass and steel; 3.052" diam x 2-1/4" lg o/a; 3/16" x #40 thd both ends of shaft; 1 spur gear, 168 straight teeth, 56 pitch, 3.00" PD, 3.052" OD x 0.187" thk; 1 spur gear, 45 straight teeth, 48 pitch, 0.9375" PD, 0.983" OD x 0.25" thk; mfd by Sangamo part #871781	First compound shaft, scanner
O-2305	- N16-G-500001-103 -	GEAR ASSEMBLY: compound shaft; bakelite, brass and steel; 1.883" diam x 2.072" lg o/a; 3/16" x #40 thd both ends of shaft; 1 spur gear, 105 helical teeth, 64 pitch, helix angle 28° 57' LH, 1.875" PD, 1.883" OD x 0.187" thk; 1 spur gear, 14 straight teeth, 56 pitch, 0.25" PD, 0.312" OD x 0.375" thk; mfd by Sangamo part #871785	Second compound shaft,
O-2306 thru O-2308	- G77-B-111-00503-1050 -	BEARING, ball: single row radial; single shield; light duty; 0.1969" bore, 0.748" OD, 0.2362" wd; 6 balls in cage; Dow-Corning DC-44 silicone grease, fluid grade; std fit; ABEC-5 std tol; mfd by Barden type 35S3; Sangamo part #840529	Compound shaft bearings

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
O-2309	- G77-B-115-00309-8016 -	BEARING, ball: single row radial; plain; light duty; 0.1875" bore, 0.5000" OD, 0.1563" wd; 6 balls in cage; Dow-Corning DC-44 silicone grease, fluid grade; std fit; ABEC-5 tol; stainless steel; mfd by Barden type SR3K3; Sangamo part #800116	General purpose
P-2301		Not used	
P-2302		Not used	
P-2303	- N17-C-70328-4797 -	CONNECTOR, plug: three round cont; straight type; 1-3/16" diam x 1-3/8" lg o/a; 10 amp 200 v; cylindrical aluminum body, anodized; molded melamine insert, tropicalized; threaded one end 7/8" diam x #20 thd; coupling ring other end 1" ID x #20 thd; AN-3106-16S-5SH; mfd by American Phenolic Corp. part #AN-3106-16S-5SH; Sangamo part #873940	Signal input
R-2301	- N16-R-50012-141 -	RESISTOR, fixed: comp; JAN type RC42BE222J; 2200 ohms ±5%; 2 w; E characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type HB-2225; Sangamo part #870017	Phasing, MG-2301
R-2302	- N16-R-50066-127 -	RESISTOR, fixed: composition; JAN type RC42BE332J; 3300 ohms ±5%; 2 w; E characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type HB-3325; Sangamo part #870018	Phasing, MG-2301
R-2303	- N16-R-50632-751 -	RESISTOR, fixed: comp; JAN type RC30BF104J; 100,000 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-1045; Sangamo part #812090	Grid bias, V-2302
R-2304	- N16-R-49921-751 -	RESISTOR, fixed: comp; JAN type RC30BF102J; 1000 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-1025; Sangamo part #812095	Limiting, grid, V-2302
R-2305	- N16-R-50335-751 -	RESISTOR, fixed: compensation; JAN type RC30BF153J; 15,000 ohms ±5%; 1 w; F characteristic; 0.562" lg x 0.225" diam; 2 axial wire leads; JAN-R-11 spec; mfd by Allen-Bradley Co. part #GB-1535; Sangamo part #813632	Cathode, pin 8, V-2303
R-2306	- N16-R-50128-751 -	RESISTOR, fixed: comp; JAN type RC30BF472J; 4,700 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-4725; Sangamo part #870136	Cathode, pin 8, V-2303
R-2307		Same as R-2303	Grid, pin 7, V-2303
R-2308		Same as R-2303	Anode, pin 6, V-2303
R-2309		Same as R-2303	Anode, pin 1, V-2303
R-2310	- N16-R-50821-751 -	RESISTOR, fixed: comp; JAN type RC30BF474J; 470,000 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-4745; Sangamo part #870127	Limiting, pin 2, V-2303
R-2311	- N16-R-50065-751 -	RESISTOR, fixed: comp; JAN type RC30BF332J; 3300 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-3325; Sangamo part #870030	Cathode, pin 3, V-2303
R-2312	- N16-R-50281-751 -	RESISTOR, fixed: comp; JAN type RC30BF103J; 10,000 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-1035; Sangamo part #812108	Voltage divider, grid, pin 2, V-2303
R-2313		Same as R-2306	Voltage divider, grid, pin 2, V-2303
R-2314	- N16-R-49966-751 -	RESISTOR, fixed: composition; JAN type RC30BF152J; 1,500 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-1525; Sangamo part #812364 (Not used for 1 speed operation)	Divider, B-2302
R-2315		Same as R-2306 (Not used for 1 speed operation)	Voltage divider, grid, pin 2, V-2303
R-2316		Same as R-2304	Voltage divider, CR-2301

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
R-2317	- N16-R-50372-140 -	RESISTOR, fixed: composition; JAN type RC42BE223J; 22,000 ohms ±5%; 2 w; E characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type HB-2235; Sangamo part #843008	Voltage divider, CR-2301
R-2318		Same as R-2317	Voltage divider, CR-2301
R-2319	- N16-R-49922-115 -	RESISTOR, fixed: comp; JAN type RC42BE102J; 1000 ohms ±5%; 2 w; E characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type HB-1025; Sangamo part #870037	Filter, +300 v supply
R-2320		Same as R-2319	Filter, +300 v supply
R-2321		Same as R-2319	Filter, +300 v supply
R-2322	- N16-R-50479-751 -	RESISTOR, fixed: comp; JAN type RC30BF473J; 47,000 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. type GB-4735; Sangamo part #870034	Decoupling, V-2304
R-2323		Same as R-2322	Decoupling, V-2304
R-2324	- N16-R-49579-751 -	RESISTOR, fixed: composition; JAN type RC30BF101J; 100 ohms ±5%; 1 w; F characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. part GB-1015; Sangamo part #843072	Voltage divider, T-2302
R-2325		Not used	
R-2326		Same as R-2311	Cathode, pin 3, V-2304
R-2327		Same as R-2303	Grid, pin 2, V-2304
R-2328		Same as R-2303	Grid, pin 7, V-2304
R-2329		Same as R-2311	Cathode, pin 8, V-2304
R-2330		Not used	
R-2331		Same as R-2324	Voltage divider, T-2303
R-2332	- N16-R-49841-127 -	RESISTOR, fixed: comp; JAN type RC42BE681J; 680 ohms ±5%; 2 w; E characteristic; JAN-R-11 spec; mfd by Allen-Bradley Co. part HB-6815; Sangamo part #873955	Cathode, V-2302
T-2301	- N17-T-75923-2576 -	TRANSFORMER, power: Navy type -304330; fil and plate type; input 117 v, 60 cyc, 0.25 amp, singlephase; 2 output windings; secd #1-680 v CT at 0.05 amps, secd #2-6.2 v at 2 amp; 2300 v ins; air cooled; HS steel case; 3.34" diam x 3.75" h excl term and mtg bkt; 7 solder lug term on bottom; 4 mtg holes 1/4" diam on 2.88" x 2.88" mtg/c; mfd by Sangamo part #873601	Anode and heater supply
T-2302	- N17-T-62655-4501 -	TRANSFORMER, AF: Navy type -304327; line type; pri 100 ohms impedance, secd 570 ohms impedance at 26 KC; HS brass case, Mumetal core; 0.91" diam x 1.39" h less term and mtg bkt; pri 58 turns #32 heavy Formvar wire, DC res 1.4 ohms, secd 138 turns #30 heavy Formvar wire, DC res 2.31 ohms; electrostatic shield between pri and secd; 4 solder lug term on bottom; three mtg holes 0.26" diam, 2 are 0.63" c to c, third is 1.06" away and ctr, ctr line of mtg holes is displaced 15° from ctr line of transf term; mfd by Sangamo part #873609	"LEFT" channel signal input
T-2303		Same as T-2302	"RIGHT" channel signal input
V-2301	For replacement use N16-T-56840-50	TUBE, electron: 6X4; rectifier; JAN type 6X4; mfd by RCA Manufacturing Co. part #6X4; Sangamo part #891014	Rectifier, D.C. power
V-2302	- N16-T-56758 -	TUBE, electron: 6V6GT/G; beam power amplifier; JAN type 6V6GT/G; mfd by RCA Mfg. Co. part #6V6GT/G; Sangamo part #840511	Servo amplifier

TABLE 5-4 TABLE OF REPLACEABLE PARTS

REFERENCE DESIG.	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME OF PART AND DESCRIPTION	LOCATING FUNCTION
V-2303	- N16-T-58241 -	TUBE, electron: 12AU7; twin triode; JAN type 12AU7; mfd by RCA Mfg. Co. part #12AU7; Sangamo part #891016	Servo amplifier
V-2304		Same as V-2303	Impedance matching, audio channel
XC-2301 thru XC-2305		Not used	
XC-2306	- N16-S-63524-6521 -	SOCKET, tube: Navy type -491534; octal; one piece saddle mtg; two oval mtg holes 5/32" x 11/32" on 1-21/32" mtg/c; round ceramic body 1-1/4" diam x 1/2" d, excluding term; phosphor bronze silver pl cont; mfd by Cinch Mfg. Co. part #51E11745; Sangamo part #812385	Holds C-2306
XC-2307		Same as XC-2306	Holds C-2307
XF-2301	- N17-F-74267-6101 -	HOLDER, fuse: retainer type; one 4AG cartridge fuse; black bakelite case with copper clips; 18 amp 250 v; 13/16" diam x 2-3/8" lg o/a; bushing mtd, 1/2" x #18 thd; 2 solder lug term; mfd by Bussman type HCM; Sangamo part #870080	Holds F-2301
XF-2302		Same as XF-2301	Holds F-2302
XF-2303		Same as XF-2301	Holds F-2303
XI-2301	- N17-L-50854-9662 -	LAMPHOLDER: candelabra; porcelain body; 125 v, 75 w; 1-9/16" lg x 1" wd x 1-5/16" h o/a; two 5/32" diam mtg holes on opposite corners of 1-7/32" x 19/32" mtg rect; two screw term located on opposite sides; mfd by Graybar Electric Co. part #325; Sangamo part #874052	Holds I-2301
XV-2301	- N16-S-62603-6666 -	SOCKET, tube: 7 pin miniature; above chassis base mtg; two mtg holes for #4 screw on 7/8" mtg/c; round mica-filled body, 1-1/8" lg x 13/16" wd x 29/32" h o/a; phosphor bronze silver pl cont; unmarked; w/o metal shock shield; w/center shield 5/32" ID w/shock shield base; mfd by American Phenolic Corp. part #147-916; Sangamo part #891089	Holds V-2301
XV-2302		Same as XC-2306	Holds V-2302
XV-2303	- N16-S-64063-6707 -	SOCKET, tube: 9 pin miniature; above chassis base mtg; two 0.095" mtg holes on 1-1/8" mtg/c; round mica-filled bakelite body, 1-11/32" lg x 15/16" wd x 13/16" h o/a; phosphor bronze silver pl cont; unmarked; w/o metal shock shield; w/center shield, 5/32" ID; mfd by American Phenolic Corp. part #59-407; Sangamo part #891018	Holds V-2303
XV-2304		Same as XV-2303	Holds V-2304
Z-2301	- N16-S-12451-1008 -	SCANNER, TRANSDUCER: 48 capacitor plates on rotor, 48 capacitor plates on stator; 0.003" to 0.004" between rotor and stator disks; 8 rpm operating speed; 4 brushes, grade 411 silver graphalloy; housing cast iron, painted finish; 13-1/4" lg x 9-11/64" wd x 13-1/4" h o/a; 4 vibration mounts top and bottom w/0.391" diam bolt hole on 4-1/4" x 10-1/2" mtg/c;provision for inspecting disk alignment; mfd by Sangamo, part #893876	Converts signals from circular to plane faced array

TABLE 5-5. MAINTENANCE PARTS KIT

Reference Designation	Name of Part	Standard Navy Stock Number	Quantity	Box No.
C-2301	Capacitor, 0.25-0.25 uf	N16-C-53433-4108	1	A
C-2306	Capacitor, 20-20-20 uf	N16-C-22641-4762	1	A
CR-2301	Rectifier, crystal, 1N70	N16-T-51770	1	A
E-2301	Brush Assembly	N17-B-88240-7175	1	A
E-2302	Brush Assembly	N17-B-88238-2146	1	A
E-2303	Brush Assembly	N17-B-88234-7201	1	A
I-2301	Lamp, incandescent	N17-L-3916-205	1	A
MG-2301	Motor Generator Unit	F17-M-69418-9219	1	A
T-2301	Transformer, Power	N17-T-75923-2576	1	A
T-2302	Transformer, A. F.	N17-T-62655-4501	1	A

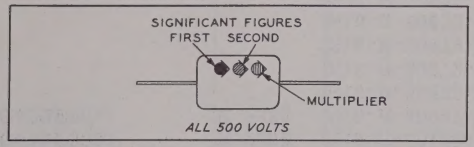
TABLE 5-6. CROSS REFERENCE PARTS LIST

JAN Designation	Key Symbol	Standard Navy Stock Number	Key Symbol	Standard Navy Stock Number	Key Symbol	BuOrd Number	Key Symbol
CE53A200Q	C-2306	F17-M-69418-9219	MG-2301	N16-S-34576-6414	H-2303	1 HCT MK 11	B-2301
CE63A200J	C-2310	G41-W-2455	H-2308	N16-S-34607-6039	H-2301		
CM30B102K	C-2313	G77-B-111-00503-1050	O-2306	N16-S-62603-6666	XV-2301	Army-Navy Type	Key Symbol
CM50B273K	C-2308			N16-S-63524-6521	XC-2306		
CP70B1EF205K	C-2302	G77-B-115-00309-8016	O-2309	N16-S-64063-6707	XV-2303		
CP70B1FF405K	C-2303			N16-T-51770	CR-2301	AN-3102-16S-5PH	J-2303
		N16-C-19713-8741	C-2310	N16-T-56758	V-2302	AN-3106-16S-5SH	P-2303
1N70	CR-2301	N16-C-22641-4762	C-2306	N16-T-56840-50	V-2301	MK 12 MOD 2 type 1C	C-2311
6V6GT/G	V-2302	N16-C-300487-126	H-2302	N16-T-58241	V-2303		
6X4	V-2301	N16-C-300798-886	H-2306	N17-B-88234-7201	E-2303		
12AU7	V-2303	N16-C-31090-4164	C-2313	N17-B-88238-2146	E-2302		
		N16-C-34672-8576	C-2308	N17-B-88240-7175	E-2301		
RC30BF101J	R-2324	N16-C-49197-3160	C-2302	N17-C-70328-4797	P-2303		
RC30BF102J	R-2304	N16-C-49957-5970	C-2303	N17-C-72604-4794	J-2303		
RC30BF103J	R-2312	N16-C-53433-4108	C-2301	N17-C-73125-2568	J-2301		
RC30BF104J	R-2303	N16-G-500001-102	O-2304	N17-F-14305-1165	F-2301		
RC30BF152J	R-2314	N16-G-500001-103	O-2305	N17-F-14309-310	F-2304		
RC30BF153J	R-2305	N16-R-49579-751	R-2324	N17-F-14309-330	F-2303		
RC30BF332J	R-2311	N16-R-49841-127	R-2332	N17-F-74267-6101	XF-2301		
RC30BF472J	R-2306	N16-R-49921-751	R-2304	N17-G-414999-191	O-2303		
RC30BF473J	R-2322	N16-R-49922-115	R-2319	N17-G-433596-281	O-2302		
RC30BF474J	R-2310	N16-R-49966-751	R-2314	N17-G-433596-311	O-2301		
RC42BE102J	R-2319	N16-R-50012-141	R-2301	N17-L-3916-205	I-2301		
RC42BE222J	R-2301	N16-R-50065-751	R-2311	N17-L-50854-9662	XI-2301		
RC42BE223J	R-2317	N16-R-50066-127	R-2302	N17-L-250763-401	N-2301		
RC42BE332J	R-2302	N16-R-50128-751	R-2306	N17-L-250884-551	N-2302		
RC42BE681J	R-2332	N16-R-50281-751	R-2312	N17-M-75247-3501	A-2305		
		N16-R-50335-751	R-2305	N17-M-75387-1823	A-2301		
		N16-R-50372-140	R-2317	N17-R-64130-5465	K-2301		
		N16-R-50479-751	R-2322	N17-T-62655-4501	T-2302		
		N16-R-50632-751	R-2303	N17-T-75923-2576	T-2301		
		N16-R-50821-751	R-2310	Z16-C-54623-4782	C-2311		
		N16-S-12451-1008	Z-2301	Z17-M-61237-4201	B-2301		

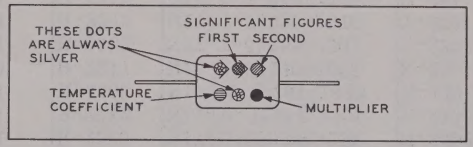
TABLE 5-7. COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODES

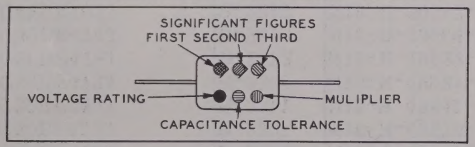
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



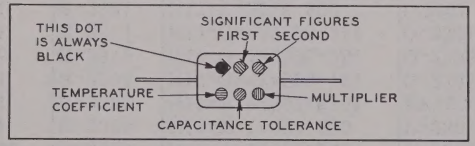
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



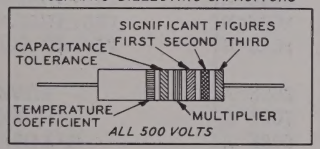
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



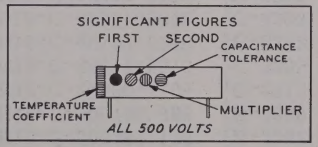
JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



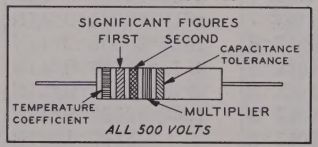
RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS
RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



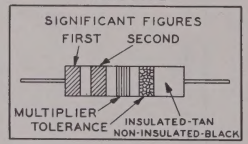
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

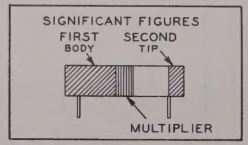
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

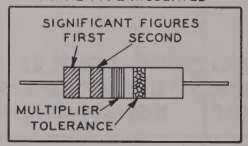


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

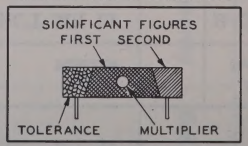


TABLE 5-8. LIST OF MANUFACTURERS

Prefix	Name	Address
CBZ	Allen-Bradley Company	118 W. Greenfield Ave., Milwaukee, Wis.
CAYT	Allen Manufacturing Company	100 Sheldon Street, Hartford, Connecticut
CPH	American Phenolic Corp.	1830 So. 54th Avenue, Chicago, Illinois
	Atlantic India Rubber Company	1453 W. Van Buren, Chicago 7, Illinois
	Barden Corporation	Danbury, Connecticut
CAYU	Barry Corp., The	179 Sidney St., Cambridge, Massachusetts
CAIS	Birtcher Corp., The	5087 Huntington Drive, Los Angeles, Calif.
CFA	Bussman Manufacturing Company	2538 W. University St., St. Louis, Mo.
CMG	Cinch Manufacturing Company	2339 W. Van Buren St., Chicago, Illinois
CG	General Electric Company	1 River Road, Schenectady, New York
	Graybar Electric Company	500 South Clinton, Chicago, Illinois
CAXP	Lord Manufacturing	1639 W. 12th St., Erie, Pennsylvania
	Navy Department, Bureau of Ordnance	Washington, D. C.
CARE	Potter and Brumfield Mfg. Co., Inc.	Princeton, Indiana
CRC	RCA Manufacturing Company	Harrison, New Jersey
CAN	Sangamo Electric Company	Springfield, Illinois

INDEX

Subject	*Figure*	*Table*	*Page*
A			
Acoustic Beam Pattern, Production of	.....	.....	2-5
Alignment Check	.....	.....	3-3
Amplifier Chassis: Component Location	4-4	.....	4-9
Applying Equipment Power	.....	.....	3-3
B			
Basic Principles	.....	.....	1-1
Beam Pattern Formation and Rotation	.....	.....	2-5
Phasing and Shading, The Lag Line	.....	.....	2-7
Production of Acoustic Beam Pattern	.....	.....	2-5
The Scanner	.....	.....	2-6
C			
Cabinet Assembly, Description	.....	.....	1-1
Cabinet Wiring, Transducer Simulator	4-6	.....	4-13
Chassis Wiring, Transducer Simulator	4-7	.....	4-15
Check, Alignment	.....	.....	3-3
Circuit Analysis:			
Directional Sensitivity Circuits	.....	.....	2-1
Servo System	.....	.....	2-1
Coil Winding Data	.....	4-2	4-10
Color Codes and Miscellaneous Data	.....	5-7	5-12
Component Location, Amplifier Chassis	4-4	.....	4-9
Component Replacement:			
Extraction of Transducer Scanner from Rack	.....	.....	4-5
Replacement of Motor Generator Unit, MG-2301	.....	.....	4-7
Replacement of 36^{X} Synchro, B-2301	.....	.....	4-6
Replacement of 1^{X} Synchro, B-2302	.....	.....	4-7
Replacement of Transducer Scanner, Z-2301	.....	.....	4-8
Signal and Servo Amplifier Chassis	.....	.....	4-8
Control Transformer, 1HCT:			
B-2301	.....	.....	4-8
B-2302	.....	.....	4-8
Conversion to Single Speed System	.....	.....	3-3
Corrective Maintenance	.....	.....	4-2
Component Replacement	.....	.....	4-5
Equipment Adjustment	.....	.....	4-8
Lubrication	.....	.....	4-9
Trouble Shooting	.....	.....	4-3
Cross Reference Parts Lists	.....	5-6	5-11

Subject	*Figure*	*Table*	*Page*
D			
Description:	.....	.....	1-1
Cabinet Assembly	.....	.....	1-1
Signal and Servo Amplifier Chassis	.....	.....	1-4
Transducer Scanner Assembly	.....	.....	1-2
Directional Sensitivity Circuits:	.....	.....	2-5
Beam Pattern Formation and Rotation	.....	.....	2-5
E			
Emergency Maintenance:	.....	.....	4-1
Fuse Failure	.....	.....	4-1
Permanently Alive Electrical Circuits	.....	.....	4-1
Equipment:			
Adjustment	.....	.....	4-8
Synchro Zeroing	.....	.....	4-8
Required But Not Supplied	.....	1-2	1-6
Supplied	.....	1-1	1-6
Extraction of Transducer Scanner from Rack	.....	.....	4-5
F			
Fuse Failure	.....	.....	4-1
G			
General Description	.....	.....	1-1
General, Theory of Operation	.....	.....	2-1
I			
Initial Tests and Adjustments	.....	.....	3-3
Applying Equipment Power	.....	.....	3-3
Alignment Check	.....	.....	3-3
Power On Observations	.....	.....	3-3
Installation	.....	.....	3-1
L			
Lag Line	2-5	.....	2-6
List of Major Units	.....	5-3	5-2
List of Manufacturers	.....	5-8	5-13
M			
Maintenance	.....	.....	4-1
Maintenance Parts Kit	.....	5-5	5-10
Mounting and Outline Dimensions	3-4	.....	3-7
O			
Observations, Power On	.....	.....	3-3
Operation	.....	.....	4-1

Subject	Figure	Table	Page
P			
Performance Tests	.....	.....	4-1
Transducer Scanner Check	.....	.....	4-1
Permanently Alive Electrical Circuits	.....	.....	4-1
Phasing and Shading, the Lag Line	.....	.....	2-7
Power On Observations	.....	.....	3-3
Production of Acoustic Beam Pattern	.....	.....	2-5
Purpose	.....	.....	1-1
R			
Reference Data	.....	.....	1-5
Removable Components, Signal and Servo Amplifier Chassis	4-2	.....	4-3
Replacement of:			
36^X Synchro, B-2301	.....	.....	4-6
1^X Synchro, B-2302	.....	.....	4-7
Motor Generator Unit, MG-2301	.....	.....	4-7
Transducer Scanner, Z-2301	.....	.....	4-8
S			
Scanner	.....	.....	2-6
Servo Amplifier Waveforms:			
at 5 Degrees	2-2	.....	2-3
at 7.5 Degrees	2-3	.....	2-4
Servo System	.....	.....	2-1
Shading Curves	2-6	.....	2-6
Shipping Data	.....	1-3	1-6
Shipping Weights and Dimensions of Spare Parts Boxes	.....	5-2	5-2
Signal and Servo Amplifier Chassis:	1-5	.....	1-5
Component Replacement	.....	.....	4-8
Description	.....	.....	1-4
Removable Components	4-2	.....	4-3
Single Speed System, Conversion to	.....	.....	3-3
Synchro Zeroing:	.....	.....	4-8
1HCT Control Transformer, B-2301	.....	.....	4-8
1HCT Control Transformer, B-2302	.....	.....	4-8
System Block Diagram	2-1	.....	2-2
System Interconnections Diagram	3-6	.....	3-11
System Pictorial	1-1, 3-3	.....	1-0, 3-5
T			
Table of Replaceable Parts	.....	5-4	5-3
Table of Tube Pin and Terminal Voltages and Resistances	.....	4-1	4-5
The Lag Line, Phasing and Shading	.....	.....	2-7
The Scanner	.....	.....	2-6
Theory of Operation	.....	.....	2-1
Transducer Element Voltages	2-4	.....	2-6
Transducer Scanner:			
Check	.....	.....	4-1
Description	.....	.....	1-2
Rotor and Stator Alignment	3-2	.....	3-3

Subject	*Figure*	*Table*	*Page*
Transducer Scanner (cont'd)			
Schematic Diagram	2-7	.....	2-7
Showing End Plate	4-3	.....	4-7
Transducer Simulator, SM-58/UQS-T1	1-2	.....	1-2
Cabinet Wiring	4-6	.....	4-13
Chassis Wiring	4-7	.....	4-15
Scanner Rack Withdrawn	1-4, 4-1	.....	1-4, 4-2
Schematic Diagram	3-5, 4-5	.....	3-9, 4-11
Showing Interior	1-3	.....	1-3
Showing Main Terminal Board	3-1	.....	3-2
Trouble Shooting	.....	.....	4-3
Operational Failures	.....	.....	4-3
Table of Tube Pin and Terminal Voltages and Resistances	.....	4-1	4-4, 4-5
Tabulation of Faults for Transducer Simulator SM-58/UQS-T1	.....	.....	4-3
U			
Unpacking	.....	.....	3-1
W			
Weights and Dimensions of Spare Parts Boxes	5-1	.....	5-2

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